MINES AND MINERAL DEPOSITS (EXCEPT FUELS) BROADWATER COUNTY, MONT.

BY GLENN C. REED

* * * * * * * * * **Information Circular 7592**

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

Work on manuscript completed July 1950. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7592."

April 1951

MINES AND MINERAL DEPOSITS (EXCEPT FUELS)
BROADWATER COUNTY, MONT.

by

Glenn C. Reed[1]

CONTENTS

	Page
Introduction and summary	1
Acknowledgments	1
Location and accessibility	2
Climate	2
Topography	4
Forestation	5
Water supply	5
Labor supply and wage scale	5
Materials and supplies	6
Power	6
Trucking costs	8
Railroad freight rates	8
Smelter schedules	9
History	12
Production	13
Geology, general	14
Metallic mines and mineral deposits	17
Radersburg region	17
Location and access	17
Physical features	17
Geologic setting	18
Black Friday	19
Bluebird	20
Bonanza	20
Congress	20
Cyclone (Simpson)	21
Delome	21
Gold Butte	21
Gold Cross (Iowa, Keystone)	22
Gopher	22
Hard Cash	23
Highland Mary	23
Iron Age	23
Iron Cross	24
Jo Dandy	24

---

[1] Mining engineer, Bureau of Mines, Minerals Division, Region II.

Information Circular 7592

CONTENTS (Cont'd.)

Page

Metallic mines and mineral deposits (Cont'd.)

Radersburg region (Cont'd.)

Jo Jo.. 25
Keating.. 25
North Home..................................... 26
Ohio-Keating................................... 26
Ruby... 27
Santa Anita.................................... 28
Spar... 28
Summit (Montana Silver Star)................... 29
Other mining properties........................ 29
Confederate region................................. 29
Location and access............................ 29
Physical features.............................. 31
Geologic setting............................... 31
Argo (Eclipse-Argo)............................ 32
Humming Bird................................... 33
Miller (Slim Jim).............................. 33
Satellite (Baker).............................. 33
Other mining properties........................ 34
Winston region..................................... 34
Location and access............................ 34
Physical features.............................. 34
Geologic setting............................... 34
Buzz... 36
Custer-Iron Age-Hyantha........................ 37
East Pacific................................... 38
January.. 39
Kelly.. 39
Little Bonanza................................. 39
Little Olga (Kleinschmidt)..................... 40
Stray Horse.................................... 41
Other mining properties........................ 41
Indian Creek region................................ 43
Location and access............................ 43
Physical features.............................. 43
Geologic setting............................... 43
Blacksmith..................................... 44
Diamond Hill................................... 45
Iron Mask...................................... 46
Little Fannie.................................. 47
Little Giant................................... 47
Lookout.. 48
Marietta....................................... 48
Queen Bee...................................... 49
Silver Wave.................................... 50
Spring Hill.................................... 50
White Horse.................................... 51
Other mining properties........................ 51

CONTENTS (Cont'd.)

Page

Metallic mines and mineral deposits (Cont'd.)
- Outlying properties.................................. 53
  - Cleo.. 53
  - Pennsylvania.. 53
- Gold placer deposits................................ 54
  - Boulder.. 55
  - Indian Creek.. 55

Nonmetallic mineral deposits............................ 55
- Diatomaceous earth.................................. 56
- Fluorite.. 56
- Ornamental stone..................................... 56
- Rock phosphate....................................... 57

References.. 58

Mineral Industry Survey table (metallic mineral deposits). 59

ILLUSTRATIONS

Fig.		Follows page
1.	Index map of Broadwater County, Mont.	2
2.	Generalized geologic map of Broadwater County, Mont.	14
3.	Geologic map of the Radersburg region.............	18
4.	Longitudinal section of the Keating mine..........	26
5.	Longitudinal section of the Ohio-Keating mine.....	26
6.	Plan of Ruby mine workings.......................	26
7.	Plan of Spar mine workings.......................	28
8.	Plan of Summit mine workings.....................	28
9.	Geologic map of the Confederate region............	30
10.	Longitudinal section of the Argo mine............	32
11.	Geologic map of the Winston region...............	34
12.	Longitudinal section of the Custer mine..........	36
13.	Longitudinal section of the East Pacific mine.....	38
14.	Longitudinal section of the January mine..........	38
15.	Geologic plan of the Kelly mine..................	38
16.	Geologic plan of the Little Bonanza mine..........	40
17.	Geologic map of the Indian Creek region...........	42
18.	Plan of the Marietta mine workings...............	48
19.	Mineral Industry Survey map of Broadwater County, Mont., showing location of metallic mineral deposits by symbol and reference number.........	54

INTRODUCTION AND SUMMARY

This report is one of a series describing investigations within the Missouri River Basin in Montana made by mining engineers of the Bureau of Mines Minerals Division, Region II. The primary purpose of these investigations is to provide information to agencies of the Department of the Interior and and others concerned with the planning of Federal power developments in the basin. The report contains such factual data as have been authorized for public distribution.

The field investigations in Broadwater County were made during the late fall of 1948 and the summer of 1949. Virtually all known metallic mineral deposits and some nonmetallic mineral deposits within the county were investigated. However, some long inactive mines and prospects on which little or no information is of record may have been omitted inadvertently. Many of the mines and prospects have been inactive for extended periods. Most of the underground workings now are inaccessible. Because of such conditions, impressions gained by the inspection of surface features have been supplemented necessarily, where possible, by information obtained from Federal and State publications.

This report covers such features as accessibility, climate, topography, power, freight rates, smelter schedules, history, production, and geology. It provides information on more than 90 metal mines and prospects and a number of nonmetallic deposits.

ACKNOWLEDGMENTS

Compilation of some of the data contained in this report was materially assisted by the courteous cooperation of the region's mine owners, company officials, operators, and county officers. Essential information concerning their respective company activities, as related to the mineral industry within the county, was provided by officials of the American Smelting & Refining Co., the Anaconda Copper Mining Co., the Montana Power Co., and the Northern Pacific Railroad.

Statistical information was supplied by the Economics and Statistics Service, Bureau of Mines, Salt Lake City, Utah. Climatological data were supplied by the U. S. Weather Bureau, Helena, Mont.

Information recorded in reports and unpublished manuscripts of the Federal Bureau of Mines, the Federal Geological Survey, and the Montana Bureau of Mines and Geology was used freely. Designation of the source of information is indicated in the text by numbers in parentheses, which refer to the list of references.

LOCATION AND ACCESSIBILITY

Broadwater County (population 3,451) is in west-central Montana between parallels 45° 50' and 46° 47' north and meridians 111° 04' to 111° 47' west. Its borders enclose an area of 1,206 square miles. The county's known mineral deposits are confined mainly to four mining regions lying to the west and northeast of Townsend, Mont. (population 1,309), the county seat. The location of these mining regions and their relation to population centers, highways, and railroads are shown on figure 1.

Road mileage between these mining regions and their nearest rail shipping points are indicated in table 1.

TABLE 1. - Road mileage between mining regions and nearest rail shipping point

Region	Shipping Point	Road mileage
Radersburg........................	Toston	12
Indian Creek......................	Townsend	12
Winston...........................	Winston	7
Confederate.......................	Clasoil	31

Helna, Mont., the State capitol, is the nearest major supply point. Custom smelting facilities within the State are available at Anaconda, East Helena, and Great Falls. Table 2 gives highway mileages from Townsend to the principal mining supply points and smelting centers within Montana and to similar centers in nearby States.

TABLE 2. - Highway distances from Townsend, Mont.

Place	Mileage
Anaconda, Mont.	111
Butte, Mont.	96
East Helena, Mont.	32
Great Falls, Mont.	128
Helena, Mont.	35
Kellogg, Idaho..................................	296
Salt Lake City, Utah............................	461
Spokane, Wash.	369

The county is served by a road network branching from U. S. Highway 10N, which closely follows the course of the Missouri River and parallels Northern Pacific Railroad trackage. Several well-ballasted and maintained secondary roads traversing the valley provide dependable year-round communication between most of the mining regions and the valley shipping points.

CLIMATE

Pronounced seasonal temperature extremes prevail. The generally low humidity, abundant sunshine, and bracing atmosphere, however, constitute a

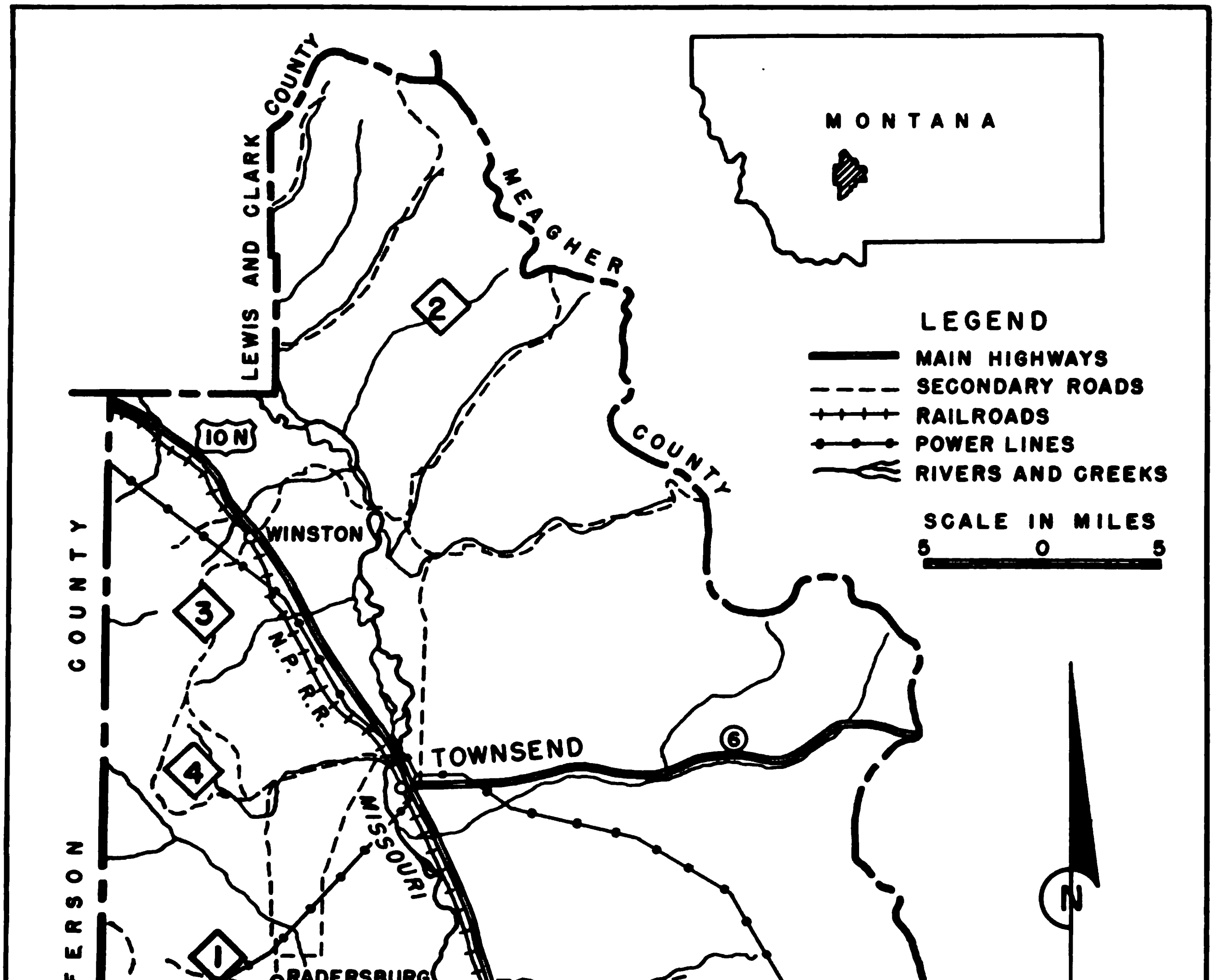


Figure I. - Index map, Broadwater County, Mont.

pleasant mountain climate. A fairly diversified agriculture is encouraged at the lower altitudes by an average growing season of 104 days.

Climatological records indicate an average annual precipitation of about 11 inches. However, the mountain areas receive a much greater precipitation, usually as snow, than indicated by records collected at valley observation points. Snow depths commonly range from 2 to 7 feet and average about 4 feet throughout the mountain areas. Although snowstorms may occur in any month of the year, unhampered communications between valley and mountain areas usually are possible from April to December.

Climatological data recorded at stations in and adjacent to Broadwater County, Mont., are shown in tables 3 and 4. These statistics were provided by the United States Weather Bureau, Helena, Mont.

TABLE 3. - Average monthly and annual precipitation1/ and snowfall, in inches, at following U. S. Weather Bureau stations in and adjacent to Broadwater County, Mont.

Station..........	Townsend2/ (Broadwater County) 4,100		Helena3/ (Lewis & Clark County) 4,124		Three Forks (Gallatin County) 4,070	
	Precipitation1/	Snowfall	Precipitation1/	Snowfall	Precipitation1/	Snowfall
Length of record, years....	21	11	51	51	21	14
January..........	0.42	9.4	0.90	10.7	0.41	3.5
February..........	.28	6.0	.64	8.2	.40	4.6
March............	.60	6.9	.77	9.2	.42	2.9
April............	.78	1.4	1.07	6.2	1.03	2.7
May..............	1.85	0.9	2.12	2.2	1.73	.6
June.............	2.28	.0	2.25	T	2.16	.0
July.............	1.10	.0	1.12	.0	1.40	.0
August...........	.91	.0	.78	T	.96	.0
September........	1.20	.1	1.25	.9	1.34	.4
October..........	.67	.3	.88	4.2	.92	2.4
November.........	.39	7.1	.73	6.9	.63	3.6
December.........	.35	7.2	.80	9.0	.55	2.8
Annual average..	10.83	39.3	13.31	57.5	11.95	23.5

1/ Includes snowfall converted to water.
2/ Eight miles east of Townsend.
3/ Two miles southwest of Helena airport.

TABLE 4. - Average temperature data, in degrees Fahrenheit, at U. S. Weather Bureau Stations in and adjacent to Broadwater County, Mont.

Station	Townsend (Broadwater County)	Helena (Lewis & Clark County)	Three Forks (Gallatin County)
Elevation, feet	4,100	4,124	4,070
Length of record, year	21	51	16
Annual average	43.0	43.7	43.1
Mean maximum:			
January	31.3	28.4	32.8
July	85.1	80.3	84.3
Annual	58.0	53.8	57.1
Mean minimum:			
January	7.0	12.1	9.8
July	47.3	54.2	49.5
Annual	28.0	33.4	29.1
Highest:			
January	57.0	63.0	64.0
July	110.0	103.0	101.0
Annual	110.0	103.0	101.0
Lowest:			
January	-43.0	-42.0	-49.0
July	27.0	36.0	31.0
Annual	-43.0	-42.0	-49.0
Latest date 32° or lower in spring	1/	Apr. 5 to June 20	July 8
Earliest date 32° or lower in fall	1/	Aug. 25 to Oct. 23	Aug. 19

1/ Freezing temperatures have occurred at some time during each month of the year.

TOPOGRAPHY

The east margin of Broadwater County is marked along much of its length by the unbroken divide of the Belt Mountains. Although the average altitude of this divide is about 8,400 feet, several summits attain altitudes ranging from 9,000 to 9,600 feet above sea level. Part of the county's west margin is marked similarly by the equally rugged but somewhat lower Elkhorn Range.

At the north end of the county the gap between these ranges is occupied by a low, uneven divide formed by the Spokane Hills. Near the county's southern extremity, a low ridge projecting westward from the Belt Mountains curves to the south and west around Toston to join the Elkhorn Range.

These divides outline a broad, northward-trending basin occupied by the Missouri River. The Missouri River enters this basin through a gorge that pierces the low ridge south of Toston and escapes on the north through a similar gorge that cuts the Spokane Hills.

Altitudes along the Missouri River range from 3,600 to 3,900 feet, whereas the average valley altitude is about 4,200 feet. Conspicuous benches, evidently remnants of former river plains, rise to moderate heights above the valley floor and join the lower flanks of the Elkhorn and Belt Mountain Ranges. Some of these benches in the northeast part of the county have been found to contain notable concentrations of placer gold.

The region's drainage is accomplished by 12 perennial streams discharging into the Missouri River. Ten of these streams issue from the Belt Mountains, whereas the remaining streams (Crow Creek and Beaver Creek) have their source in the Elkhorn Range. All of these streams have comparatively steep gradients - 50 to 300 feet or more per mile.

FORESTATION

The broad Missouri River Valley, benchlands, and rolling foothills are treeless except for scattered cottonwoods, aspen, and willows, which mark the courses of the perennial streams and the river. The higher benchlands are profusely blanketed in places with sagebrush and greasewood. The lower flanks of both the Belt Mountains and the Elkhorn Range are only sparsely wooded with cedar and juniper.

The north slopes at the higher altitudes are generally thickly forested with lodgepole pine and fir. These forested areas are almost entirely within the National Forest boundaries. Although much of this timber is adapted to mine support, its generally small size limts its commercial value. Some of the timber at medium altitudes adjoining Beaver, Indian, and Crow Creeks was recently frost-killed, causing these areas to have a peculiarly stark appearance.

WATER SUPPLY

Although the average aggregate summer discharge of Broadwater County's perennial streams has been estimated to range between 65 and 100 cubic feet per second (1), the available surface-water supply is meager.

A marked surface-water deficiency exists in the mining region adjacent to Radersburg. However, as exploration along many of the lodes penetrated the water table, adequate supplies of water generally suitable for mining and metallurgical use were developed.

Other mining areas in the drainage basins of Beaver Creek, Weasel Creek, and Indian Creek have access to limited but dependable supplies of water. Water requirements of many of the early placer operations were obtained by means of extensive ditch systems that have since been destroyed. Consequently, exploitation of most of the remaining placer gravel areas is limited to the brief spring run-off.

LABOR SUPPLY AND WAGE SCALE

The available supply of experienced mine labor in Broadwater County appears adequate to meet present and immediately foreseeable future demands.

Most of the current operations are conducted by small leasing groups on a profit-sharing basis. Several mines employ small crews at day's pay and occasionally at contract rates.

Mine labor throughout the county is not union-affiliated at present. Wage rates in effect in November 1949, however, are closely patterned after the Butte wage scale. Hourly rates currently paid at mines in Broadwater County compare with Butte rates as follows:

	Hourly basis	
Labor classification	Broadwater County	Butte district
Unskilled surface...........	$1.12	$1.33
Miners......................	1.25	1.39
Millmen.....................	1.25	1.39
Truck drivers...............	1.25	1.46
Dozer operators.............	1.75	1.48
Dragline operators..........	1.85-2.25	1.48

The hourly base rates apply for an 8-hour shift and a 40-hour week. The mines at Butte operate on a 6-day basis. Time and one-half is paid for overtime.

MATERIALS AND SUPPLIES

Materials and supplies incident to mine operation can be obtained from warehouse stocks either at Butte or Helena, Mont. A bit-reconditioning service in Helena is available to Broadwater County's prospectors and small mine operators. Several mine-equipment concerns with district offices at Helena provide prompt replacement-part and repair service.

Timber required for ground support at the currently active mines usually is cut from company tracts within claim boundaries. The larger requirements of former medium-scale operations generally were obtained by contract from tracts within the National Forest.

The relative inactivity of the mineral industry within Broadwater County is due partly to the present high costs of materials and supplies.

POWER

All electric energy for industrial and domestic consumption is supplied to Broadwater County by the Montana Power Co. A transmission circuit enters the county from the East Helena substation on the west and extends southward to Winston, Townsend, and Radersburg. At Radersburg the loop strikes westward, crosses the county border, and joins the Butte-Great Falls line at Boulder, Mont.

The East Helena-Townsend leg of this circuit has a capacity of 13,500 kilowatts at an operating level of 10,000 volts. The Townsend-Radersburg and the Radersburg-Boulder lines have capacities of 3,500 kilowatts and 2,800 kilowatts, respectively.

Stubs from the circuit have been extended to the East Pacific, Kleinschmidt, and Vossburg mines, on Weasel Creek, to the Iron Mask mine and a placer dredge west of Townsend and to the Keating, Ohio-Keating, and Jo Dandy mines west of Radersburg. Activated stubs in 1949 were limited to the East Pacific, Kleinschmidt, Iron Mask, and Keating mines. Lines to the remaining properties have been dismantled.

A second circuit, operating at 100,000 volts, extends eastward from Butte, Mont., closely follows the county's south boundary, and continues to Two Dot, Mont. Energy for Broadwater County mining loads, however, has not been drawn from this circuit.

Surveys were in progress in 1949 for a third circuit planned to cross the county from north to south and connect with the substation at Trident, Mont. It is expected that any future energy required in the Confederate mining region probably would be obtained through stubs from this line.

The connected horsepower of the recently active mines in Broadwater County have been estimated by an official of the Montana Power Co. as follows:

	Status in 1949	Connected horsepower
East Pacific......	Active	75
Iron Mask.........	Idle	100
Keating	do.	250
Kleinschmidt......	Active	25
Ohio-Keating......	Idle	150

Charges for industrial energy supplied by the Montana Power Co. throughout the State are given in table 5. This schedule is based on a sliding scale for actual kilowatt-hour consumption plus a charge based on peak demand.

TABLE 5. - Montana Power Co. power rates, Schedule GS-44

Rate per kw.-hr.	Kilowatt hours
$0.75	For the first 12 or less
.035	For the next 288
.025	For the next 1,500
.015	For the next 3,200
.009	For the next 15,000
.007	For the next 200 kw. of demand
.005	For all additional kw.-hr.
Plus demand charge:	
No charge	First 10 kw.
$0.95	Next 20 kw.
.75	All additional kw.

TRUCKING COSTS

Favorable grades prevail on all trucking routes from the county's mining regions to railhead. The average drop in altitude between mine portal and shipping point is about 1,700 feet. Haul distances from these regions to the closest shipping point average about 13 miles and rarely exceed 35 miles.

Most of the few currently active properties in Broadwater County limit ore trucking to the late spring, summer, and fall. However, ores and concentrates from the Marietta and East Pacific mines are hauled during the entire year.

Trucking rates in effect at properties operating in 1949 together with several rate-controlling factors are given in table 6.

TABLE 6. - Current ore-truck hauling rates in Broadwater County, Mont.

Mine	Elevation	Destination	Distance, miles	Cost/ton	Cost/ton mile
Marietta.......	6,960	Townsend	15	$2.00	$0.133
Ruby...........	5,780	Toston	18	2.25	.125
East Pacific 1/.	5,730	East Helena	25	2.50	.100
Little Bonanza.	6,080	do.	29	3.00	.103
Iron Cross.....	4,690	Trident	35	2.25	.064
Marietta.......	6,960	East Helena	46	3.50	.076
Spar 1/.........	6,400	Washoe Sampler	102	6.50	.063
East Pacific...	5,730	Winston	7	1.50	.214

1/ Hauled on company account.

RAILROAD FREIGHT RATES

Freight rates quoted in October 1949 on ores and concentrates from selected Northern Pacific Railroad shipping points in Broadwater County to the Montana smelters were as follows:

Value per ton, not exceeding	$15	$25	$35	$50	$100	Over $100 1/
To A.S. & R. Co. smelter, East Helena, Mont., from:						
Lombard....................	1.74	1.96	2.32	2.80	2.86	-
Toston.....................	1.43	1.60	1.96	2.51	2.51	-
Townsend...................	1.27	1.43	1.79	2.32	2.32	-
Winston....................	.95	1.08	1.43	1.60	1.79	-
To Washoe Sampler, A.C.M. Co., Butte, Mont., from:						
Lombard....................	2.53	2.86	3.22	3.74	4.10	-
Toston.....................	2.53	2.86	3.22	3.74	4.10	-
Townsend...................	2.53	2.86	3.22	3.74	4.10	-
Winston....................	2.53	2.86	3.22	3.74	4.10	-

Value per ton, not exceeding	$15	$25	$35	$50	$100	Over $100 1/
To A.C.M. Co. zinc plant, Great Falls, Mont., from:						
Lombard..................	4.12	4.64	5.34	6.34	6.80	-
Toston...................	3.81	4.28	4.98	6.25	6.45	-
Townsend.................	3.65	4.11	4.81	6.06	6.26	-
Winston..................	3.33	3.76	4.45	5.34	5.73	-

1/ For each $50 a ton (or fraction thereof) increase in value above $100 a ton, add 20 percent to the rates provided herein for ores and concentrates of value of $100 a ton.

Freight rates between the above-listed shipping points and smelters in Idaho, Utah, and Washington are not available. However, rates may be established in specific instances on application to the railroad traffic agent.

SMELTER SCHEDULES

Most of the western custom milling plants and smelters generally find it impossible to quote blanket or "open" schedules for purchases of ores and concentrates. Applicable schedules usually are established upon analysis of representative ore samples submitted by a prospective shipper. In many instances favorable schedules are negotiated and based on contractual tonnage agreements between seller and buyer.

The following summarized schedules were in effect in October 1949. It is emphasized that these schedules are useful in preliminary calculations only.

East Helena smelter, American Smelting & Refining Co., copper-lead-gold-silver ores and concentrates

Payments for metals:

Gold - Minimum paid for, 0.03 ounce per ton.

Ounces per ton	Per ounce
0.03 to 3.0..	$31.81825
Plus 3.0...	32.31825

Silver - Pay for 95 percent at average of the Handy & Harman, New York, quotations, or Mint price, less minimum deduction 1 troy ounce per dry ton.

Lead - If 3 percent or over by wet assay, deduct from wet assay 1.5 units (a unit is 20 pounds) and pay for 90 percent of the remaining lead at the average of the daily published A.S. & R. Co. quotations for common desilverized domestic lead for delivery in New York City, less 1.8 cents per pound of lead accounted for.

Copper - If 1 percent or over, deduct from wet copper assay 1 unit and pay for 100 percent of the remaining copper at daily net refinery quotations for electrolytic cathodes as published in E. & M.J. Metal & Mineral Markets of New York, less a deduction of 6 cents per pound of copper accounted for.

Deductions:

Base charge - $8 per net dry ton for treatment of ores and concentrates having a settlement lead content of 20 percent or less; deduct 10 cents per ton for each unit of lead over 20 percent, fractions in proportion; $7 per ton for those having no payable lead content.

Arsenic and antimony (combined) - 2 percent free; excess charged at 50 cents per unit, fractions in proportion. 0.1 percent of lead content by wet assay allowed free; excess charged at 50 cents per pound.

Zinc - 10 percent free; excess charged at 30 cents per unit, fractions in proportion.

Sampling and assaying - Charge $10 per lot when less than $200 value and $20 per lot when over $200 value for shipments of less than 5 tons dry weight. Charge $5 per lot when less than $200 value and $10 per lot when over $200 value for shipments less than 10 tons dry weight.

Washoe sampler, Anaconda Copper Mining Co., Butte, Mont., copper, gold, and silver ores and concentrates

Payments for metals:

Copper - 96 percent of copper content, with minimum deduction of 10 pounds per ton, at E. & M. J. average price of electrolytic copper for week ending Wednesday preceding date of sampling, less 2.5 cents per pound.

Silver - 95 percent of silver content, with minimum deduction of 1 ounce per ton at Government price less 2 cents per ounce. Silver not eligible for Government price will be paid for at open-market quotations, as quoted by E. & M. J.

Gold - 95 percent of gold content, with minimum deduction of 0.01 ounce per ton, at $20 per ounce, plus 90 percent of premium in excess of $20.67 per ounce. (This is equivalent to paying for 100 percent at $34.81825 per ounce.)

Treatment charge, f.o.b. Washoe sampler, Butte, Mont.:

Base charge - $4 per ton.
Add 10 percent of sum of metal payments in excess of $15 per dry ton.
Add 12 cents for each 1 percent iron (Fe).
Deduct 2.5 cents for each 1 percent of silica (SiO_2) in excess of alumina (Al_2O_3)
Maximum total treatment charge to be $5.50 per dry ton.

Digitized by Google Original from THE OHIO STATE UNIVERSITY

In case company elects to have shipments made direct to the smelter at Anaconda for sampling, the base treatment charge will be $3.75 per dry ton, f.o.b. Anaconda Reduction Works, Anaconda, Mont., with maximum total treatment charge of $5.25 per dry ton. Lots of less than 10 tons will be assessed an extra sampling charge of $5 flat on each lot.

Electrolytic zinc plants, Anaconda Copper Mining Co., at Anaconda and Great Falls, Mont., zinc concentrates

The Anaconda Copper Mining Co. does not quote open schedules for the treatment of zinc ores or concentrates at its Anaconda or Great Falls plants. Because of impurities, which complicate treatment in these plants, only certain types of concentrates are accepted. A prospective shipper is offered terms of purchase only after the suitability of the concentrates involved is determined by complete analysis of a representative sample.

Terms of purchase for zinc concentrates accepted by these plants are given in the following schedule covering specific shipments made by one operator during 1949.

Payments for metals in zinc concentrates:

Zinc................	Eighty percent (80%) of zinc content at St. Louis price for prime western zinc.
Lead................	Eighty percent (80%) of lead content in excess of 3 percent, at New York price, less 2 cents per pound.
Silver..............	Eighty percent (80%) if 1.0 ounce per ton or over.
Gold................	One hundred percent (100%) if 0.01 ounce per ton or over, at $27.024 per ounce.
Other metals.......	No payment shall be made for any other metal or metals contained in concentrates, and such metals shall be the property of the Anaconda Co.

Prices for zinc and lead shall be those quoted by Engineering & Mining Journal for week of arrival of concentrates at plants of Anaconda.

Treatment charge:

Base treatment charge shall be thirty dollars ($30.00) per dry ton of concentrates delivered and accepted, based on St. Louis price of prime western zinc of ten and one-half cents (10-1/2¢) per pound; a cost of labor in the zinc plants of the Anaconda Copper Mining Co. at Anaconda and Great Falls, Mont., based at $11.40 per 8-hour day with the addition to or subtraction from said base treatment charge per dry ton of concentrates of one cent (1.0¢) for each one cent (1.0¢) increase or decrease in said cost of 8-hour day employment; a lead content of three percent (3%) and arsenic plus antimony content of 0.125 percent.

There shall be added to, or subtracted from, said base treatment charge one dollar ($1.00) per dry ton of concentrates for each one cent (1.0¢) per pound increase or decrease in the price of prime western zinc at St. Louis above or below ten and one-half (10-1/2¢) per pound, fractions proportionately. Fifty cents (50¢) per dry ton of concentrates shall be added to said treatment charge for each one percent (1%) lead below three percent (3%) in such concentrates, fractions in proportion. Twenty-five cents (25¢) per dry ton of concentrates shall be added for each one percent (1%) of insoluble material plus iron. Twenty cents (20¢) per dry ton of concentrates shall be added for each 0.10 percent arsenic plus antimony in excess of 0.125 percent.

HISTORY

In July 1864, western Montana territory was stirred by the discovery of placer gold at the present site of Helena. The first discovery of valuable mineral in Broadwater County was made in the winter of 1864, when gold-bearing gravel was found in Confederate Gulch a short distance below its junction with Boulder Creek. Increasingly rich gravels found upstream and in the tributary Montana and Cement Gulches culminated in 1866 with the discovery of the fabulous Montana Bar. Diamond City, numbering several thousand inhabitants, was known as "the mining capital of western Montana." In the fall of 1866 a $900,000 shipment of gold dust, representing the clean-up of a short run on Montana Bar, was hauled overland to Fort Benton and shipped by boat down the Missouri River to St. Louis (2).

Placer mining in the Confederate Gulch area declined rapidly in the 1870's. Diamond City, formerly the county seat, was virtually deserted by 1880. Confederate Gulch and its tributaries have since been reworked many times, usually with modest success; almost every year brings a brief flurry of small-scale placer activity. In 1949, A. R. Douglas, of Missoula, Mont., operated a small drag line and tractor-mounted screening plant for a short period on Boulder Bar. The sole inhabitant of the area, E. B. Robinson, was prospecting the former sites of saloons and stores for gold dust and coins lost by the early miners.

Pay gravel found near the present site of Radersburg led to the discovery of the Keating vein in 1866. In 1870, construction of a 15-stamp amalgamating mill enabled the property to operate continuously until 1877, when the known oxidized ores were exhausted. A small blast furnace constructed in 1878 at Toston to smelt the Keating's sulfide ores soon was abandoned. Activity at Radersburg finally revived with the completion of the Northern Pacific Railroad and the installation of smelting facilities at Butte and Helena (3). Coincident with the development of the Keating mine, a number of other lodes in the Radersburg region were exploited intermittently. A substantial output was obtained from the Black Friday, Ohio-Keating, North Home, and Hard Cash properties.

Almost continuous production was maintained at the Keating mine up to 1948, when mounting costs finally obliged suspension of the operation. In 1949, mining in the Radersburg area was at a virtual standstill, with the exception of several small-scale high-grading operations and a few prospecting ventures.

Prospectors, encouraged by the Confederate Gulch and Radersburg strikes, swarmed over the adjoining region in the late 1860's. The East Pacific vein on Weasel Creek was discovered in 1867. About this time pay gravel found along the lower reaches of Indian Creek led to the discovery of lode deposits near the present site of Hassel. The Little Giant, Blacksmith, Diamond Hill, and John L. were among the earliest productive mines of this area. Hassel became a typical boom camp of considerable magnitude; it is reputed to have numbered Calamity Jane among its earlier inhabitants.

The Diamond Hill property was explored intensively and partly developed by a well-financed Scottish organization. Two amalgamating mills containing 40 and 120 stamps were erected in the 1890's. However, metallurgical difficulties ultimately resulted in the termination of the venture. From 1940 to the present, the property has been selectively mined by small-scale open cutting.

A number of lodes near the head of Indian Creek have been partly explored and developed by a succession of operators. In 1949 a small tonnage was being produced at the Marietta property during the course of rehabilitation.

Systematic development of the East Pacific vein was delayed until 1887; it ultimately attained a substantial production record. Current output from the property is limited to the recovery of metal from the old dumps by a small electrified gravity plant.

Many additional lodes briefly exploited throughout the county have contributed significant amounts to the production record. Most of these operations, however, were characteristically short-lived. In 1949, mining in Broadwater County was confined to a few small-scale operations and several prospecting ventures. It is estimated that not more than 40 men were directly engaged either on full or part time in the county's mineral industry. Excepting boom times, but under conditions more favorable to mining than now exist, the employment figure consistently exceeded 250 men.

PRODUCTION

Broadwater County production statistics show a total value of $13,459,000 for base and precious metals recovered during the years 1901-48, inclusive. The value of lode and placer gold recovered during this period was $9,341,000. Gold recovered from lode mining operations comprised 63 percent of the total metal produced, whereas placer gold production amounted to only 6 percent. The total value of the silver, lead, copper, and zinc amounted to $4,118,000 or 31 percent of the county's recorded metal output.

Mining in the region that later was incorporated into Broadwater County apparently began in 1866. Unfortunately, no dependable record of actual production prior to 1901 is known. Estimates indicate that production from 1866 to 1900, inclusive, probably exceeded the recorded output during the period 1901-48 by several million dollars. As nearly as can be determined, about 75 percent of the value of this early production apparently was derived from gold recovered chiefly from the Confederate Gulch and other placers in the Belt Mountains. The value of the total metal output is believed, therefore, to have amounted to about $31,000,000.

Total county metal output, by years, for the period 1901-48, inclusive, is given in table 7. Metal output of selected mines within the county during the same period is given in table 8. These tables have been compiled from data supplied by the Economics and Statistics Service, Bureau of Mines, Salt Lake City, Utah. It should be noted that the tables are expressed in terms of recovered metal. Consequently, they do not indicate the true metal content of the ores mined.

GOELOGY, GENERAL

During the course of field studies comprising the basis of this report, a close relationship between structural deformation, igneous activity, and subsequent mineralization in most of the county's mining regions was apparent. Although the detailed complexities of this relationship could not be satisfactorily unraveled in the brief period allotted to field work, it is anticipated that a clearer understanding may be afforded by the completion of studies currently being made by the Federal Geological Survey.

The following discussion is confined to a brief mention of the rock units and their distribution throughout the county, the broader structural features of the region, and the apparent relationship between these features and the known mineralized areas (fig. 2).

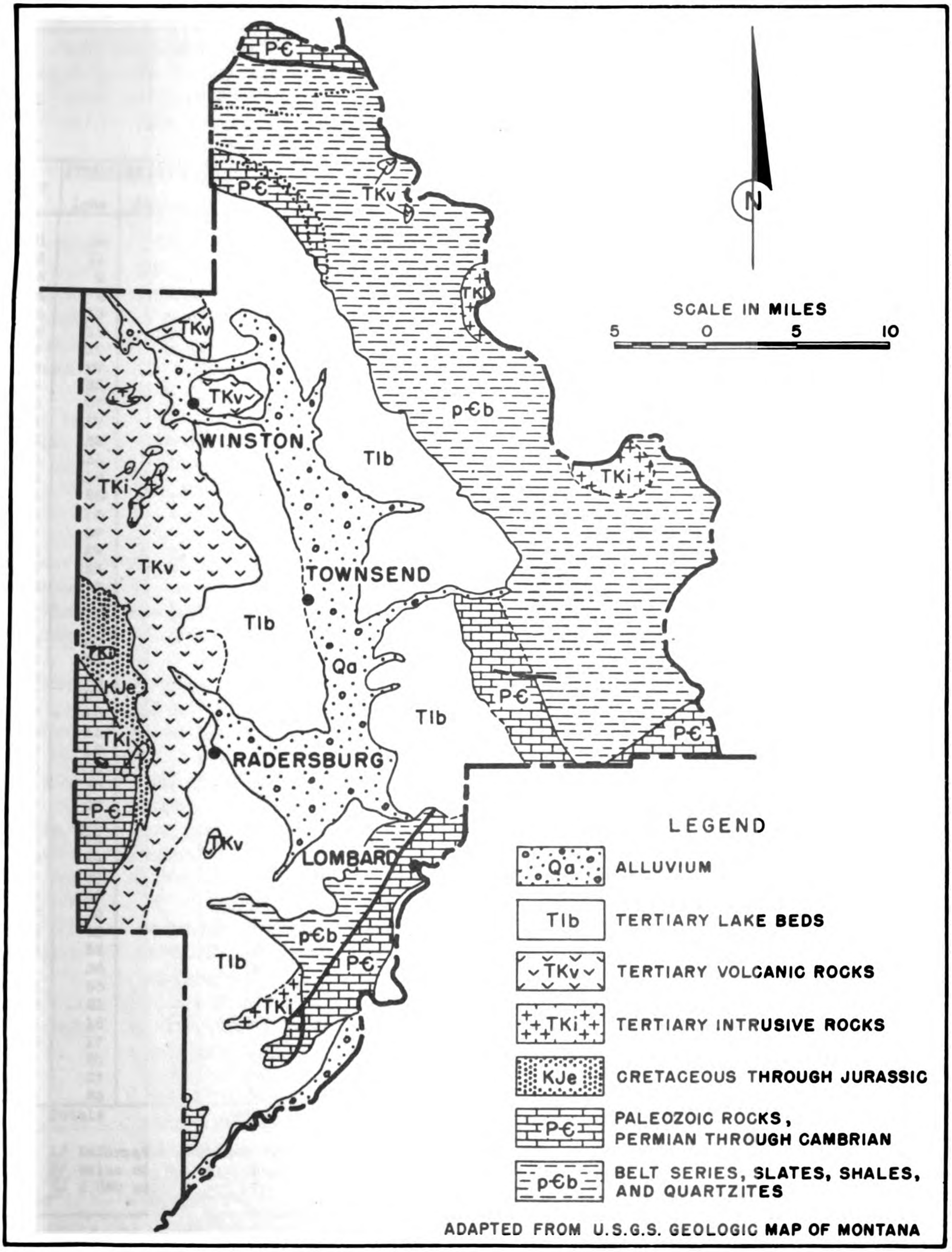
The eastern part of Broadwater County is occupied largely by Proterozoic and Paleozoic sediments ranging from Algonkian to Mississippian. These gently arched rocks, which comprise the main mass of the Belt Mountains are invaded locally by sheets and occasional stocks of late Cretaceous diorite and gabbro.

Tertiary clays, sands, and tuff, together with Quaternary gravels, cover the extensive, basinlike lowland adjoining the Belt Mountains on the west. These deposits occupy nearly half of the total area of the county.

The Elkhorn Range, marking both the county's west boundary and the rim of the lowland, consists largely of late Cretaceous andesites, tuffs, and breccias intruded by occasional quartz monzonite stocks. Along the southwest border, sedimentary rocks ranging from pre-Cambrian to lower Cretaceous have been arched into an elongated, north-trending fold.

The El Dorado-Lombard strand of the Lewis and Clark overthrust is one of the region's principal structural elements. This strand is exposed in Oregon Gulch immediately beyond the county's north border (2). It presumably is buried beneath Tertiary deposits throughout much of its course in Townsend Valley. The fault finally emerges from the valley fill northeast of Toston, curves abruptly to the southwest, and continues to a point 5 miles north of Three Forks, Mont.

A series of secondary northwest-trending faults slice the eastern flanks of the Elkhorn Range between Radersburg and Winston. One member of this series exposed along Indian Creek and at Hassel has an apparent horizontal displacement of about 1,100 feet and may be traced over a strike distance of 7 miles. About 1 mile north of the Iron Mask adit, another member of this northwest-striking fault series can be traced for a distance of 10 miles. Many of the known centers of mineralization are confined closely to the locus of intersection of these secondary faults and the monzonite stocks.


PЄ
TKv
PЄ
N
TKi
SCALE IN MILES
5 0 5 10
TKv
TKv
pЄb
WINSTON
Tlb
TKi
TKi
TKv
TOWNSEND
Tlb
TKi
KJe
Qa
Tlb
PЄ
TKi
RADERSBURG
PЄ
PЄ
TKv
LOMBARD
pЄb
Tlb
PЄ
TKi
LEGEND
Qa ALLUVIUM
Tlb TERTIARY LAKE BEDS
TKv TERTIARY VOLCANIC ROCKS
TKi TERTIARY INTRUSIVE ROCKS
KJe CRETACEOUS THROUGH JURASSIC
PЄ PALEOZOIC ROCKS, PERMIAN THROUGH CAMBRIAN
pЄb BELT SERIES, SLATES, SHALES, AND QUARTZITES

ADAPTED FROM U.S.G.S. GEOLOGIC MAP OF MONTANA

Figure 2. - Generalized geologic map of Broadwater County, Mont.

TABLE 7. - Mine production of gold, silver, copper, lead, and zinc in Broadwater County, Mont., 1901-1948, in terms of recovered metals

Year	Producing mines		Ore sold or treated (short tons)	Gold				Silver		Copper		Lead		Zinc		Total value
	Lode	Placer		Ounces			Value	Ounces lode & placer	Value	Pounds	Value	Pounds	Value	Pounds	Value	
				Lode	Placer	Total										
1901	16	2	12,643	7,071	65	7,136	$147,511	38,262	$22,957	-	-	1/	1/	-	-	$170,468 2/
1902	11	2	4,441	4,640	41	4,681	93,672	70,852	37,552	150,000	$16,050	1,467,040	39,863	-	-	187,137
1903	8	1	2,602	310	24	334	6,751	12,806	6,425	311,800	10,193	95,278	2,057	-	-	25,426
1904	8	6	1,350	1,217	665	1,882	38,917	42,231	24,167	-	-	295,749	12,743	-	-	75,827
1905	19	4	10,516	5,547	238	5,785	119,599	58,627	35,411	49,647	7,745	656,606	30,861	-	-	193,616
1906	19	5	15,119	7,380	201	7,581	156,723	47,853	32,061	7,096	1,370	359,889	20,514	-	-	210,668
1907	19	12	15,261	3,321	291	3,612	74,660	11,192	7,387	660,152	132,030	143,570	7,609	-	-	221,686
1908	27	7	14,728	7,051	197	7,248	149,822	25,502	13,516	833,803	110,062	286,102	12,016	-	-	285,416
1909	32	12	16,040	12,100	268	12,368	255,664	12,216	6,352	180,693	23,490	50,941	2,190	-	-	287,696
1910	27	8	14,883	15,317	257	15,574	321,955	21,480	11,600	124,938	15,867	245,935	10,821	-	-	360,243
1911	27	12	27,772	29,050	248	29,298	605,642	13,387	7,095	140,558	17,570	149,276	6,717	-	-	637,024
1912	32	6	20,197	17,344	182	17,526	362,306	15,431	9,490	285,460	47,101	52,541	2,364	-	-	421,261
1913	31	10	18,132	17,510	172	17,682	365,522	12,101	7,309	398,791	61,813	55,281	2,432	-	-	437,076
1914	19	10	27,205	23,610	196	23,806	492,119	14,200	7,853	484,977	64,502	32,252	1,258	-	-	565,732
1915	28	12	26,159	19,985	278	20,263	418,869	17,931	9,091	675,937	118,289	80,421	3,780	-	-	550,029
1916	13	6	7,328	3,825	166	3,991	82,491	7,223	4,753	700,542	172,333	46,480	3,207	--	--	262,784
1917	37	6	11,144	2,634	239	2,873	59,389	17,352	14,298	931,359	254,261	328,200	28,225	15,363	1,567	357,740
1918	29	5	7,374	505	212	717	14,826	11,237	11,237	573,635	141,688	137,490	9,762	-	-	177,513
1919	17	3	220	362	31	393	8,112	3,362	3,765	23,871	4,440	19,447	1,031	-	-	17,348
1920	18	6	951	319	251	570	11,775	10,239	11,160	9,522	1,752	401,551	32,124	-	-	56,811
1921	20	9	3,028	1,970	115	2,085	43,119	7,641	7,641	161	21	287,358	12,931	-	-	63,712
1922	12	5	8,791	1,564	52	1,616	33,405	6,966	6,966	4,587	619	46,512	2,558	-	-	43,548
1923	20	5	11,486	936	32	968	20,019	18,880	15,482	15,349	2,256	642,101	44,947	14,944	1,016	83,720
1924	26	7	8,166	852	124	976	20,183	22,438	15,033	4,042	529	563,367	45,069	12,240	795	81,609
1925	22	12	2,060	604	236	840	17,351	13,529	9,389	4,138	588	376,418	32,748	-	-	60,076
1926	27	6	17,777	2,754	124	2,878	59,493	35,682	22,265	3,768	528	854,506	68,360	13,650	1,024	151,670
1927	18	7	12,978	1,920	220	2,140	44,238	60,102	34,078	16,595	2,174	1,342,549	84,581	49,232	3,151	168,222
1928	16	4	8,090	795	179	974	20,123	44,818	26,219	12,021	1,731	1,552,697	90,056	9,168	559	138,688
1929	18	4	6,541	752	87	839	17,349	46,396	24,729	12,224	2,151	2,412,941	152,015	97,525	6,437	202,681
1930	28	6	828	616	112	728	15,033	9,413	3,624	2,317	301	284,978	14,249	1,974	95	33,302
1931	33	11	8,315	3,158	182	3,340	69,055	8,637	2,505	7,025	639	182,671	6,759	73,800	2,804	81,762
1932	57	16	17,944	5,374	268	5,642	116,607	15,702	4,428	2,206	139	146,600	4,398	-	-	125,572
1933	64	20	2,526	2,311	316	2,627	54,308	9,126	3,194	6,297	403	88,865	3,288	-	-	61,193
1934	74	35	7,672	5,282	381	5,663	197,919	17,670	11,423	11,075	886	151,054	5,589	-	-	215,817
1935	69	34	32,463	7,354	144	7,498	262,506	44,306	31,845	7,964	661	193,000	7,720	14,068	619	303,351
1936	50	12	46,341	6,623	87	6,710	234,829	39,832	30,850	9,652	888	171,457	7,887	-	-	274,454
1937	65	40	40,754	7,474	94	7,568	264,880	30,826	23,844	5,000	605	250,000	14,750	-	-	304,079
1938	50	19	61,476	10,012	859	10,871	380,485	28,478	18,410	4,908	481	248,652	11,438	-	-	410,814
1939	48	28	70,329	17,333	2,568	19,901	696,535	31,179	21,164	22,731	2,364	422,319	19,849	-	-	739,912
1940	56	28	91,428	20,156	6,395	26,551	929,282	27,322	19,429	22,000	2,486	329,700	16,485	-	-	967,682
1941	36	19	43,375	11,479	3,374	14,853	519,855	39,652	28,197	27,000	3,267	700,700	46,947	165,600	15,401	613,667
1942	53	33	64,400	20,129	9,467	29,596	1,035,860	47,752	33,957	26,500	3,127	634,000	36,138	-	-	1,109,082
1943	21	6	22,186	3,778	19	3,797	132,895	52,560	37,376	33,000	4,290	1,005,000	75,375	223,500	24,138	274,074
1944	18	-	10,926	703	-	703	24,605	51,345	36,512	16,400	2,214	944,400	75,552	1,016,000	115,824	254,707
1945	17	1	14,812	625	13	638	22,330	33,615	23,904	7,200	972	528,000	45,408	1,432,400	164,726	257,340
1946	20	3	10,804	1,645	1,632	3,277	114,695	49,630	40,101	22,000	3,564	776,000	84,584	1,594,000	194,468	437,412
1947	27	11	25,491	3,110	1,216	4,326	151,410	33,021	29,884	51,700	10,857	586,000	84,384	626,200	75,770	352,305
1948	26	5	3,918	838	774	1,612	56,420	17,789	16,100	5,800	1,259	326,900	58,515	115,400	15,348	147,642
Totals			908,970	319,245	33,292	352,537	$9,341,114	1,307,791 3/	$862,028	6,906,441	$1,250,556	20,952,794	$1,382,154	5,475,064	$623,742	$13,459,594

1/ Information not available.
2/ Value of lead not included.
3/ 3,880 ozs. silver recovered from placer operations.

TABLE 8. - Recorded production of selected mines in Broadwater County during the period 1901-48, in terms of recovered metals

Mine	Ore treated or sold, short tons	Gold, fine ounces	Silver, fine ounces	Copper, pounds	Lead, pounds	Zinc, pounds
RADERSBURG REGION						
Black Friday.....	7,921	13,820	8,580	6,495	39,653	-
Cyclone (Simpson)	399	335	118	-	128	-
Hard Cash........	1,007	1,032	466	1,082	53	-
Joe Dandy........	9,294	270	110,635	1,502	6,321,979	13,261
Keating..........	412,471	157,538	43,557	2,127,368	-	-
North Home.......	3,830	244	66,654	1,390	179,141	28,787
North Star.......	1,928	60	16,385	4,565	409,647	96,131
Ohio-Keating.....	190,062	58,863	12,256	38,317	-	-
Ruby Silver......	3,993	20	20,021	3,012	355,460	700,322
Santa Anita......	1,563	40	8,886	1,738	720,017	17,010
Spar.............	1,037	39	23,481	416	154	5,847
CONFEDERATE REGION						
Argo.............	31,736	15	727	4,153,333	-	-
Humming Bird.....	43	54	75	-	-	-
Miller (Slim Jim)	1,146	9,108	5,329	3,297	1,179	-
Satellite (Baker)	1,291	711	1,437	84	23,641	-
WINSTON REGION						
Custer-Iron Age..	54,229	12,324	45,057	17,578	674,165	1,050
East Pacific.....	35,647	10,358	364,490	119,681	4,486,527	827,561
January..........	3,106	335	16,498	6,659	312,477	212,648
Little Bonanza...	273	11	7,105	1,639	205,856	14,161
Little Olga (Kleinschmidt).	4,354	207	81,382	8,704	581,078	3,024
Stray Horse......	493	183	10,420	2,200	105,605	-
Vosburg..........	23,855	6,690	34,283	4,795	76,840	15,363
INDIAN CREEK REGION						
Blacksmith.......	1,558	1,809	641	398	3,810	-
Iron Mask........	23,454	110	115,904	11,548	1,858,796	3,477,253
John L.	32	15	238	1,305	1,468	-
Little Giant.....	399	335	118	-	128	-
Marietta.........	5,411	6,717	40,654	4,193	520,608	-
Park-New Era.....	11,348	3,251	7,453	14	76,108	-
Queen Bee........	796	491	2,083	1,571	99	-
Silver Wave......	593	453	5,380	551	177,682	-
St. Louis........	148	56	238	73	815	-
Vulture..........	8	2	46	-	884	-

The predominant trend of most of the region's productive lodes is north. In the Beaver Creek area, however, many of the productive veins strike eastward. In the region west of Hassel, a number of veins paralleling the northwest-striking secondary faults have been explored. The aggregate output to date from these latter lodes has been small.

A detailed description of the geology of the area is contained in U. S. Geological Survey Bulletin 842, "Metalliferous Deposits of the Greater Helena Mining Region." (2)

METALLIC MINES AND MINERAL DEPOSITS

The principal mines and prospects of Broadwater County are within four regions, each of which contains several mining districts (fig. 1). In this report, preference has been given to a system of regional groupings, inasmuch as the individual districts are bounded indefinitely and referred to locally by several names.

Although many properties were inspected, the scheduled program of field investigations permitted few detailed mine examinations. The location of most of the productive metallic mines and mineral deposits in Broadwater County are indicated on the Mineral Industry Survey map that accompanies this report. Information concerning these mines and deposits is summarized in the Mineral Industry Survey table. Other mining properties on which only meager information was obtainable are listed and described briefly in tables 9, 10, 11, and 12. No significance with respect to its relative merit, should be attached to the possible omission of a specific property from the text.

The principal mining activities in the county during 1948-49 consisted of several intermittent, small-scale operations producing siliceous gold and lead ores. In addition, two short-lived placer operations and a number of sporadic prospecting and "pocket-hunting" ventures were in progress. In 1948 the county's metallic mineral output had dropped to a 15-year low.

Radersburg Region

Location and Access

Radersburg (population 100) is a small mining community 10 miles west of Toston, Mont., by maintained county roads. Toston (population 150) is a farming center 46 miles southeast of Helena, Mont., on U. S. Highway 10N. It is served by the Logan-Helena branch of the Northern Pacific Railroad.

Physical Features

The Radersburg region embraces a moderately rolling area of about 35 square miles along the eastern flank of the Elkhorn Range. Altitudes range from 4,300 feet at Radersburg to 7,000 feet or more along the crest of the Elkhorn Range and the county boundary 7 miles to the west.

The region's drainage is eastward by several small streams, which merge into Crow Creek southeast of Radersburg. Crow Creek discharges into the Missouri River immediately north of Toston. At most localities throughout the mining area, the year-round surface-water supply generally is inadequate for metallurgical needs. However, several operations have successfully utilized mine drainage waters in both gravity concentration and cyanidation plants.

Much of the region is untimbered or only sparsely covered with juniper and gnarled cedar. Moderate stands of lodgepole pine and fir suitable for mine support grow along the higher northern slopes of the Elkhorn Range. Most of the forested areas are within the Helena National Forest boundary.

Geologic Setting

The rock formations exposed in the Radersburg (fig. 3) region include sedimentaries, extrusives, intrusives, and volcanics ranging from the Algonkian to the early Tertiary period. Andesitic rocks and occasional late Cretaceous monzonite plugs occupy nearly all of the east half of the area, whereas the crest of the Elkhorn Range and the west portion are chiefly of sedimentary origin (fig. 3).

The Greyson shale member of the Belt series is the oldest recognized sedimentary formation. This member crops out at the center of a small structural dome 6 miles west of Radersburg. The overlying Spokane member is extensively exposed on the axis and flanks of a broad, north-trending anticline along the county's west border. Succeeding formations ranging from a basal Cambrian quartzite to lower Cretaceous shales are exposed in uninterrupted sequence to the east and north, where they are covered by late Cretaceous and Tertiary andesites.

The Spokane shales are overlain unconformably by the relatively thin Cambrian Flathead quartzite and a succeeding series of Cambrian, Devonian, and Carboniferous shales and limestones about 4,000 feet thick. The massive, light-colored, Madison limestone is one of the most conspicuous members of the group. The resistant Pennsylvanian Quadrant quartzite overlying the Madison formation also affords a prominent, easily identified, stratigraphic marker.

Phosphatic shales and sandstones lying between the Quadrant quartzite and the Jurassic Ellis sandstones are equivalent to the Phosphoria formation (2). Coarse-grained, quartzitic sandstones containing a basal conglomerate lying above the Jurassic rocks are believed to belong to the Kootenai formation of lower Cretaceous age. These rocks are succeeded by thin-bedded shales, which tentatively have been correlated with the lower Cretaceous Benton group (4).

The Radersburg andesites and related rocks have a total thickness of more than 1,000 feet. Their aggregate thickness before erosion probably approached 2,000 feet. These andesites commonly are porphyritic in texture and consist of several distinct types. Their continuity and relative age have not been established clearly. They are believed to range from pregranite to postgranite age. More than half of the region's productive veins are within andesite; these veins have accounted for about 90 percent of the recorded output.

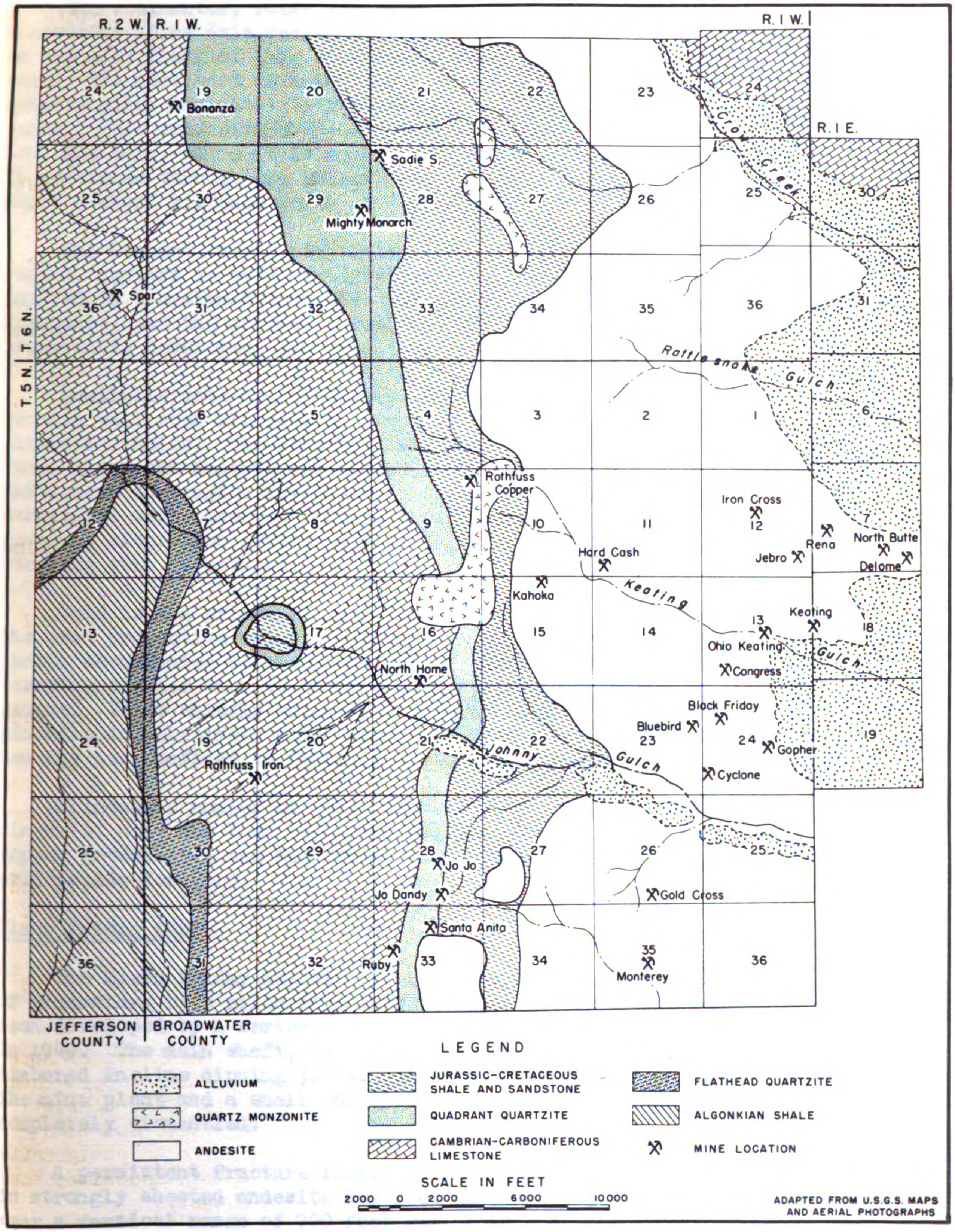


Figure 3. - Geologic map of the Radersburg region, Broadwater County, Mont.

The sedimentary rocks are involved in a moderately broad anticline having a north-trending axis nearly coinciding with the county's west border. Strata on the east flank of this structure strike northward and dip 30° to 80° eastward. The northward alinement of a comparatively narrow zone of monzonite-granite plugs may constitute a structural feature of considerable significance. This zone extends about 38 miles northward from the west flank of Lone Mountain, where it is marked by a small area of hornblende granite (3). It continues through the Radersburg, Indian Creek, and Winston regions to a point a short distance north of Canyon Ferry.

The Lombard overthrust, lying to the southeast beyond the Radersburg region, appears to be directly responsible for the zone of crustal weakness implied by the alined intrusive masses, the persistent north-striking vein fractures, and the northwest faults. These latter faults, although not all prominently developed, are numerous.

Available data are inadequate to support any conclusive statement concerning wall rock alteration. Several veins are enveloped by pronounced alteration halos. The principal examples of intensely altered wall rock are found along the Keating and adjacent Ohio-Keating vein structures. Other veins throughout the region have less conspicuous alteration zones; a few vein structures were observed to be enclosed by comparatively unaltered rock. In general, alteration effects appear to be most pronounced along the north-striking vein structures.

Gold is the principal metal recovered from the Radersburg ore deposits. The most productive veins are in andesite; they contain auriferous pyrite in quartz accompanied by minor amounts of calcite. Other veins in andesite carrying smaller amounts of gold usually are accompanied by a quartz-pyrite gangue. Veins chiefly valuable for lead commonly contain silver and zinc minerals in relatively minor amounts. Such veins, occasionally manganiferous, usually are confined to fracture systems in Paleozoic sedimentary rocks.

Although a number of veins contain accessory copper sulfides and secondary minerals, none has been exploited for its copper content. The small amount of copper produced in the Radersburg region has been recovered from ores valued principally for gold.

Black Friday (Au)

The Black Friday deposit (fig. 3) includes nine patented claims southwest of Radersburg by 3 miles of unimproved mine access roads. This deposit has been developed by a series of shallow adits and eight shafts, all inaccessible in 1949. The main shaft, at an altitude of 4,860 feet, is a two-compartment, timbered incline dipping 72° W. It is flooded within 30 feet of the collar. The mine plant and a small concencentrator near the main shaft have been completely dismantled.

A persistent fracture filling striking N. 10° E. and dipping steeply west in strongly sheeted andesite has been developed by shafts and shallow adits over a vertical range of 700 feet and along a strike length of 3,500 feet. This structure continues southward beyond the Black Friday deposit into the adjoining Emma and Cyclone claims.

Surface exposures along the structure on the Black Friday group show the vein to consist of a 5-foot zone of crushed and altered andesite containing occasional lenses of auriferous pyrite and limonite accompanied by calcite and occasional pyrolusite stains. At least four northwest-striking veins up to 2 feet in width intersect the Black Friday structure in a characteristic gash pattern. Local reports indicate the richest ores were found along the locus of these intersections. According to available records, the recovered metal content of the mined ore averaged 1.74 ounces gold and 1.0 ounce silver a ton (5).

Bluebird (Au-Ag-Pb)

The Bluebird claim (fig. 3) is a short distance southwest of the Black Friday incline. According to Stone (3), this property was explored in 1910. Apparently little work has been accomplished during the years intervening to the present. No information is available concerning either history or output. Presumably, production has been small. In 1949 all workings were inaccessible.

Two prospect shafts, not more than 100 feet deep, have been sunk on a steep-dipping vein structure in intensely altored and pyritized andesite. The andesite walls are strongly sheeted. The vein strikes N. 70° W., dips 67° NE., and appears to be about 4 feet wide. A horizontal range of at least 600 feet is indicated by the placement of the shafts.

The vein minerals are auriferous pyrite, galena, and sparse sphalerite in a siliceous gangue.

Bonanza (Ag-Pb)

The Bonanza prospect (fig. 3) is at an altitude of 7,200 feet. It is 10 miles northwest of Radersburg by unimproved mine access roads and wagon trails. The property apparently has been idle for many years. All workings are inaccessible. Reliable information regarding history and output are not available.

Ten or more short adits and several shallow prospect shafts explore a steep, northeast-trending fracture filling and replacement in Madison limestone over a vertical interval of 200 feet and a horizontal range of 600 feet. The enclosing limestone beds strike N. 35° W. and dip about 25° NE.

Near the collar of one prospect shaft, a narrow bedding replacement veinlet was observed to diverge from the main structure. However, no clear impression could be gained concerning the main locus of mineralization. The close alinement of the adits and prospect shafts suggests that the principal development was confined to the steep-dipping fracture.

The dumps contain fragments of galena, cerussite, limonite, and pyrolusite. The gangue minerals are barite, calcite, and quartz.

Congress (Au)

One of the region's earlier prospects is the Congress group (fig. 3), consisting of five patented claims in sec. 13, T. 5 N., R. 1 W. This group, at an altitude of 4,800 feet, is 3 miles southwest from Radersburg by mine access roads and wagon trails. Its history and production records are unknown. In 1949 the single shaft working was inaccessible.

Excavation at the collar of the caved shaft has exposed a fracture filling and replacement vein in andesite. This vein is about 2 feet wide, strikes N. 68° W., and dips steeply northeast. No ore minerals were found on the dump. According to Winchell (3), the vein contained galena, cerussite, wulfenite, limonite, and pyrolusite in a siliceous gangue.

A narrow tongue of monzonite striking about N. 50° W. terminates a short distance north of the shaft. Its eastward extent is obscured by the waste dump and valley fill. A few monzonite fragments scattered about the dump indicates that the intrusive probably is penetrated by the mine workings.

Cyclone (Simpson)(Au-Ag)

The Cyclone deposit (fig. 3), consisting of two patented claims, is 4-1/2 miles southwest of Radersburg by unmaintained roads and wagon trails. A shallow adit and two prospect shafts explore and partly develop the southward extension of the Black Friday vein over a vertical interval of 200 feet and a horizontal range of 1,500 feet. The south shaft, at an altitude of 4,760 feet, is flooded a short distance below the collar. The adit and north shaft both are inaccessible. Relatively small waste dumps at these openings indicate that the workings probably are not extensive. According to Stone (4), ores from this property were treated in a small stamp mill prior to 1910.

At the few accessible exposure, the vein zone consists of several closely spaced, parallel fractures in moderately altered andesite. The average width of this zone is about 3-1/2 feet. It strikes N. 10° E. and dips from 64 to 68° NW. The vein minerals are auriferous pyrite, limonite, occasional copper oxides, and pyrolusite in a siliceous gangue. Several ore fragments containing galena and sphalerite were found on the west dump. Production records indicate that the recovered metal content of the ore averaged about 0.58 ounce gold and 0.76 ounce silver a ton (5).

Delone (Au)

The Delone prospect (fig. 3) is immediately west of Radersburg. A weakly mineralized replacement and fracture filling along a conglomerate-andesite contact has been explored to a reported depth of 65 feet by a two-compartment inclined shaft.

This working was inaccessible in 1949. The contact exposed at the surface a short distance from the incline strikes N. 60° W. and dips about 75° SW. It is weakly mineralized over a width of 3 feet with limonite, pyrolusite, quartz, and occasional crystals of epidote. The limonite presumably is an alteration product of auriferous pyrite.

Gold Butte (Au)

The Gold Butte prospect at an altitude of 4,500 feet is 9 miles south of Radersburg in sec. 7, T. 4N.R.I.E. A number of narrow parallel and subparallel veins enclosed in hornblende granite have been exposed by shallow prospect cuts. The strongest vein has been opened to a depth of 150 feet by a two-compartment prospect shaft. In 1949 this shaft was flooded to a point 50 feet below the collar. All equipment has been removed from the property.

The vein strikes N. 20 W., dips vertically, and is reported to range from 4 inches to 1 foot in width. Ore fragments found on the dump contain sparse copper oxides, limonite, specularite, and pyrite cores enclosed by limonite. The pyrite is auriferous, and occasional specks of native gold are found in the limonite. Smelter returns on test shipments indicated an average value of about $15 a ton in gold.

Gold Cross (Iowa, Keystone)(Au)

The Gold Cross mine (fig. 3) is 7-1/2 miles southwest from Radersburg at an altitude of 5,000 feet. In 1949 all workings on the property were inaccessible. Reliable information regarding history or output was not available.

The andesites in this area have been intruded and locally altered by several small monzonite plugs. Two westward-converging structures have been partly developed by shallow shafts and adits over a vertical interval of 150 feet and along a horizontal range of 900 feet. Prominently developed sheeting accompanying both veins ranges upward to 60 feet in width. Both structures, dipping steeply south, appear to have an average mining width of 3 feet. The north vein, evidently the strongest, strikes N. 63° W.; the south vein strikes N. 40° W. At the west these veins are 160 feet apart.

Ore fragments found on the dumps contain pyrite, limonite, and quartz. Near the portal of the north adit several tons of pyritic concentrates was found among the ruins of a small gravity concentration plant.

Gopher (Au-Ag-Pb)

The Gopher mine (fig. 3) is 2-1/2 miles southwest from Radersburg at an altitude of 4,700 feet. An unknown but probably small output of lead-gold ore has been taken from seven shallow prospect shafts and several small surface cuts. The shafts were inaccessible in 1949.

The workings explore a fracture filling and replacement vein in bleached and pyritized andesite along a horizontal range of 1,000 feet and over a vertical interval of about 150 feet. This structure strikes N. 65° W. and dips 78° NE.; it averages about 2-1/2 feet in width. The enclosing andesite is moderately sheeted to a distance of 5 feet on each side of the vein.

Ore fragments found on the dumps contain galena, cerussite, smithsonite, pyrite, and limonite in a lightly copper-stained, siliceous gangue. In 1948 a small shipment sorted from one of the dumps contained the following:

	Ounce per ton
Gold...............	0.38
Silver.............	9.68
	Percent
Copper.............	.25
Lead...............	8.7
Zinc...............	1.6

Hard Cash (Au-Ag)

The Hard Cash mine (fig. 3) is 5 miles west from Radersburg at an altitude of 5,200 feet. The property has been idle since 1941; all workings are inaccessible. Rich gold ores are reported to have been mined during the period 1880-1900. The mine was reopened in 1931 and intermittently operated at a small scale to 1941. Activity since 1936 apparently was confined to dump-sorting operations.

The Hard Cash vein has been partly developed and explored by three adits and a shallow shaft along a horizontal range of 560 feet and over a vertical interval of 150 feet. Underground workings probably exceed 5,000 feet in length.

The vein, enclosed in highly altered andesite, strikes N. 43° W. and dips 70° NE. Its width ranges from 1 to 3 feet. The ore minerals are auriferous pyrite, sparse sphalerite, copper sulfides, and limonite in a siliceous gangue. According to Winchell (3), one ore shoot was developed over a length of 250 feet.

Production records from 1901 indicate that the recovered metal content of the ore averaged about 1.025 ounces gold and 0.46 ounce silver a ton (5). In 1933 a small tonnage averaging nearly 2 ounces in gold was produced.

Highland Mary (Pb-Zn)

The Highland Mary prospect is 7-1/2 miles southwest from Radersburg. It adjoins the Gold Cross property on the southeast. The prospect's history is unknown; its output apparently was nominal.

An unusually strong sheeted zone in altered andesite has been explored by a single shaft opening and several prospect cuts. The shaft evidently has been inaccessible for many years. The small waste dump suggests that the depth of exploration probably was not more than 150 feet.

At the surface, the sheeted zone strikes N. 60° W. and dips 83° SW.; it is about 6 feet wide. Its horizontal range is at least 550 feet. The structure appears to be an en echelon segment of the Gold Cross vein system. Ore fragments found on the shaft dump consist of pyrite, galena, and scant sphalerite in an intensely altered andesite gangue.

Iron Age (Au)

The Iron Age mine is in Keating Gulch, a short distance east of the Black Friday property. The underground workings were inaccessible in 1949; all

Digitized by Google Original from THE OHIO STATE UNIVERSITY

equipment had been removed. According to local reports, the property has not been operated for many years. Information concerning output is not available.

Two shallow inclined shafts and several small open cuts develop a replacement vein in sheared and pyritized andesite over a horizontal range of 1,600 feet. This structure ranges from 3-1/2 to 5 feet in width at exposures in the open-cuts and stope holings. The mining width, however, appeared to be not more than 3 feet.

The vein curves in strike and is convex to the northwest. At its north extremity the vein strikes N. 55° E. and dips 62° NW. On the south, however, it strikes N. 35° E. and steepens in dip to 72° NW. The predominant vein minerals are pyrite (probably auriferous), limonite, and scant quartz contained in highly altered andesite gangue.

Iron Cross (Fe-Ti)

The Iron Cross mine (fig. 3) is 2-1/2 miles northwest from Radersburg at an altitude of 4,740 feet. In the early 1880's a small tonnage of magnetite taken from this property was used at the Toston smelter for flux. Since 1944 the deposit has been exploited by small-scale open-cut methods. During the spring and summer months of 1948, about 500 tons of intermediate-grade magnetite ore was produced each month. This material was purchased by the Ideal Cement Co. at Trident, Mont., where it is used in the preparation of type V cement. Total ore production to date is estimated at about 4,000 tons.

Cretaceous sandstones arched into a small northward-plunging fold have been replaced by magnetite over widths ranging from 7 to more than 15 feet. The beds strike N. 40° E. and dip 25° SE. at the site of the open-cut operations. They extend northward from the open-cut site over a distance of 2,000 feet to the crest of the plunging fold. The central part of this interval, a distance of 1,100 feet, is overlain by valley fill.

A channel sample taken over a width of 3-1/2 feet at the open-cut contained 44.1 percent Fe and 9.6 percent TiO_2. A second sample composited from 150 tons of ore hauled to the Ideal Cement Co. plant contained 43.1 percent Fe and 9.3 percent TiO_2.

The deposit has been mined to a depth of 9 feet over a length of 300 feet. An Ingersoll-Rand 160-cubic foot compressor powers a jackhammer and a small slusher hoist used to scrape the broken material into a truck loading bin.

Jo Dandy (Ag-Pb)

The Jo Dandy group (fig. 3), consisting of five patented claims, is 9-1/2 miles southwest from Radersburg at an altitude of 5,300 feet. Intensive development, starting in 1920 and continuing through 1929, resulted in a substantial metal output. During recent years, however, only a small tonnage is produced annually by hand sorting and screening of the waste dumps.

The property is developed to a depth of 600 feet by a two-compartment vertical shaft with six levels. According to local reports, these levels, aggregating 3,500 feet, have explored the vein over a horizontal range of 1,000 feet. Pardee reports that the structure may be traced by surface prospect cuts for a distance of half a mile or more (2). In 1949 the shaft was flooded to the 50-foot level.

The principal sedimentary rocks exposed in the area are quartzites of the Quadrant formation. These rocks, on the east limb of a large anticline, strike north and dip 50° to 70° eastward. They enclose several persistent bedding replacement veins which range from 1 inch to 1 foot in width. A number of pipe-like ore shoots have been localized at intersections between these bedding veins and a series of eastward-striking cross-fractures. The ore shoots, plunging steeply parallel with the dip of the cross-fractures, persist in depth below the explored area. According to Pardee the ore shoots ranged from 5 to 75 square feet in cross-section area.

The ore minerals are cerussite, wulfenite, and galena in a hematite gangue accompanied by manganese oxides and calcite. Production records show that the recovered metal content of the ore averaged 11.9 ounces silver a ton and 34.0 percent lead (5).

Jo Jo (Ag-Pb)

The Jo Jo prospect (fig. 3) is immediately north of the Jo Dandy group. A shallow incline and one connecting adit have partly explored the northward extension of the Jo Dandy vein system. These workings have a combined length of 2,000 feet and extend over a vertical interval of 100 feet. Although several small ore shoots have been extracted since 1927, recent operations have been sporadic and confined chiefly to small-scale hand methods. In 1949 the property was idle and unequipped.

A single east-trending cross fracture in quartzite has been explored over a horizontal extent of 350 feet. The enclosing beds strike N. 30 E. and dip 30 to 45 SE. Small, eastward-plunging, pipelike ore shoots occur at junctions between the cross-fracture and several weak bedding veinlets. The cross-section area of the ore shoots usually is less than 25 square feet. The central part of the ore shoots commonly contains a core of cerussite and galena ranging from 4 inches to 1 foot in width.

The predominant ore minerals are cerussite, galena, and wulfenite in a gangue containing hematite, limonite, and calcite. The tenor of the ore is similar to that of the Jo Dandy ore.

Keating (Au)

The Keating group (fig. 3) occupies parts of sec. 18, T. 5 N., R. 1 E. and sec. 13, T. 5 N., R. 1 W. The principal workings are 1-1/2 miles west of Radersburg at an altitude of 4,700 feet. Since discovery in 1866, it has ranked among the foremost producers of lode gold in the State of Montana. Peak output was reached in 1938, when 44,500 tons of ore was mined and concentrated.

The operation was suspended during the recent war years, resumed in 1946, and terminated in 1947 because of mounting production costs. All equipment has been sold, and the mill plant has been dismantled. The mine now is flooded and completely inaccessible.

The Keating vein has been developed by 2 shafts and 10 levels over a vertical interval of 1,100 feet and along a horizontal range of 2,200 feet (fig. 4). This vein is an unusually persistent fracture filling and replacement ranging from 1-1/2 feet to 5 feet in width in altered andesite porphyry. It strikes N. 20° W. and dips 63° SW. The principal ore minerals are suriferous pyrite and occasional flecks of chalcopyrite. The intensely altered andesite gangue is accompanied by calcite and a small amount of secondary quartz.

Production records indicate that the recovered metal content of the ore averaged 0.38 ounce gold a ton and 0.25 percent copper (5). According to Winchell (3), segments of the vein marked by abundant quartz were low in gold content. Consequently, such segments were not extracted. Company maps show that about 60 percent of the developed vein structure has not been stoped.

North Home (Ag-Pb)

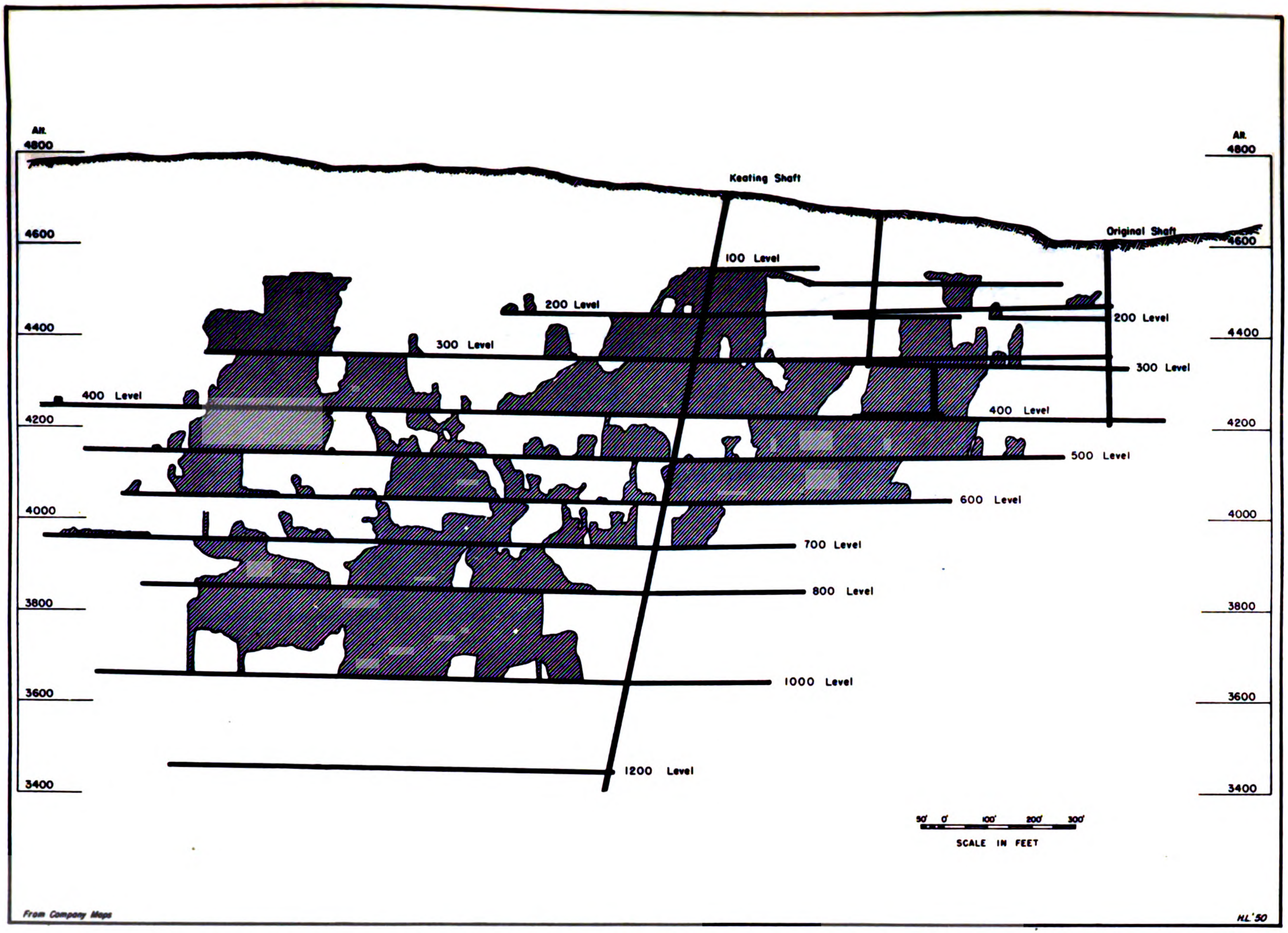
The North Home mine (fig. 3) is at an altitude of 5,400 feet. It is reached by 8 miles of mine roads westward from Radersburg and up Keating Gulch. According to local reports, the mine has been a small but consistent producer of "high-grade" silver ores since its discovery in the 1880's. In 1947 and 1948 several hundred tons of ore was screened and shipped from waste dumps. The mine was idle in 1949; all equipment had been removed and the underground workings were inaccessible.

The deposit is a narrow fracture filling and replacement vein about 4-1/2 feet wide on the east limb of a northward-trending anticline. The enclosing wall rock, believed to be Madison limestone, has been extensively shattered and healed with fine-grained, banded calcite. The vein strikes N. 5° E. and dips 70° SE. It appears to have a horizontal extent of about 200 feet. This structure is developed by a single-compartment vertical shaft to a reported depth of 300 feet.

Ore fragments on the waste dumps contain galena, smithsonite, limonite, and sparse manganese oxides in a gangue consisting of barite, siderite, calcite, and dolomite. Production records show that the average recovered metal content of the North Home ores was 2.3 percent lead, 0.06 ounce gold, and 17.4 ounces silver a ton. The recovered metal content from waste-dump screenings in 1947 and 1948 averaged 5.4 percent lead, 2.3 percent zinc, 0.01 ounce gold, and 7.7 ounces silver a ton (5).

Ohio-Keating (Au)

The Ohio-Keating mine (fig. 3) is about 2,300 feet west of the Keating shaft. This lode, presumably discovered shortly after the Keating discovery, was exploited steadily to 1943, when underground work was discontinued. Available production records indicate that the mine ranks second in county output.



From Company Maps

Figure 4. - Longitudinal section of the Keating mine, Radersburg region, Broadwater County, Mont.

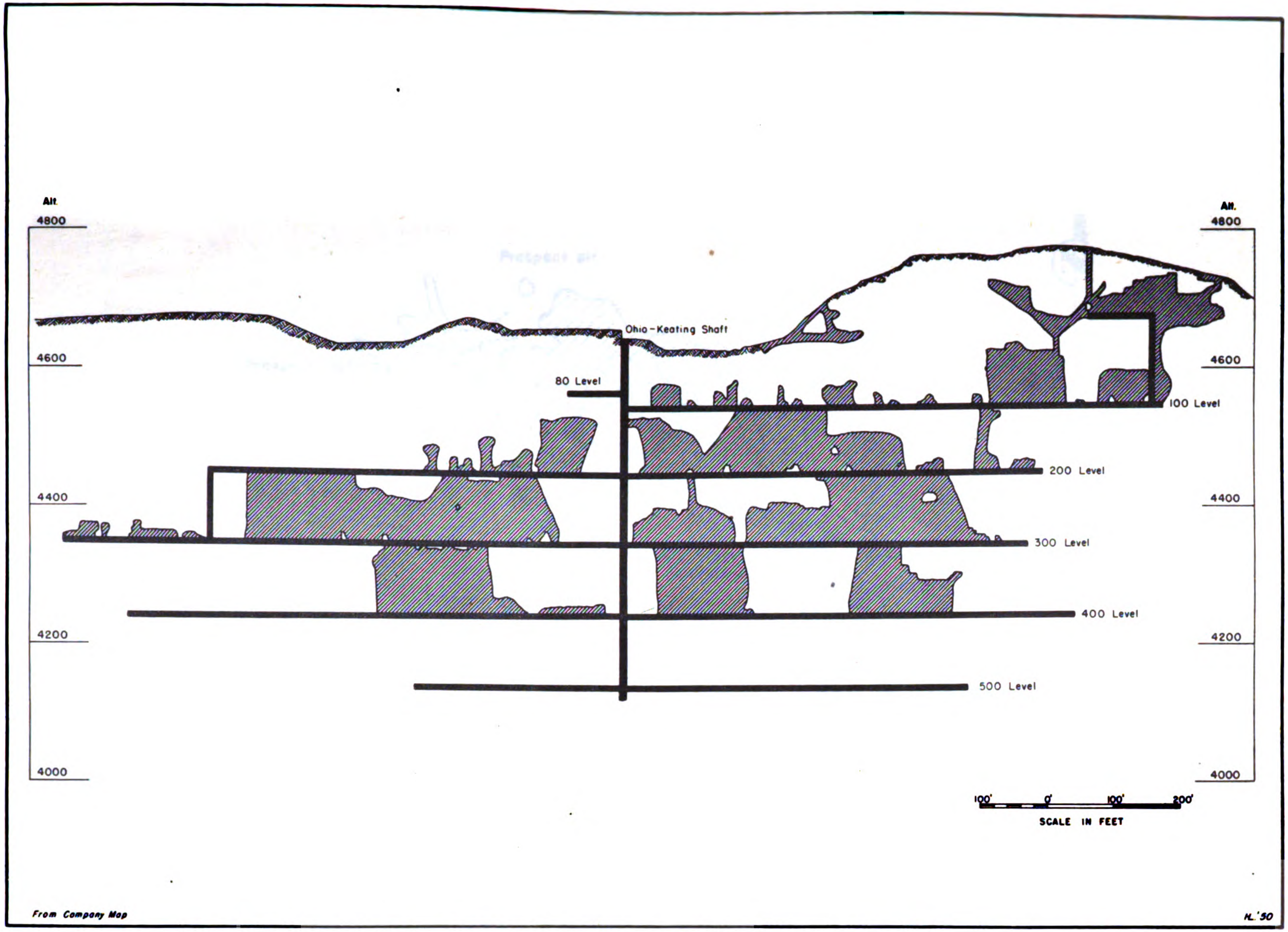
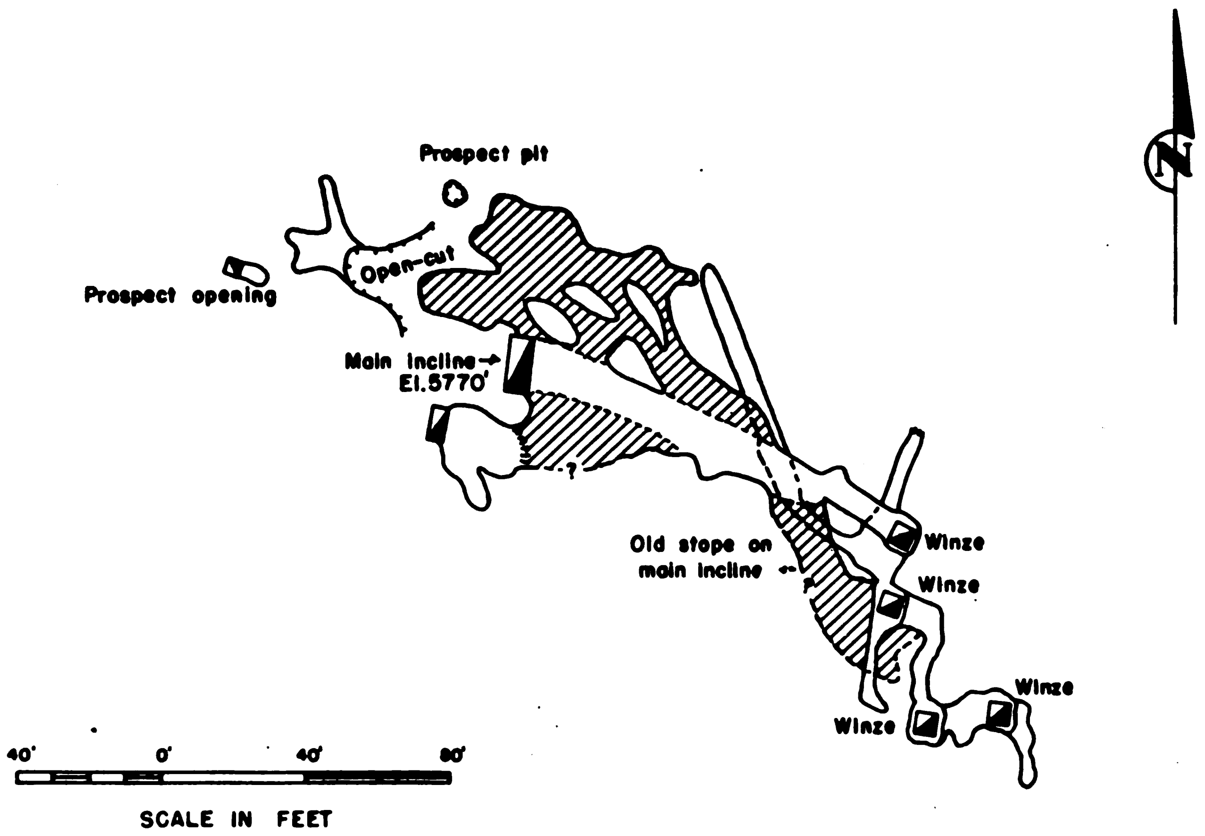


Figure 5. - Longitudinal section of the Ohio-Keating mine, Radersburg region, Broadwater County, Mont.



Adapted from U.S.G.S.

Δ50

Figure 6. - Plan of Ruby mine workings, Radersburg region, Broadwater County, Mont.

The property formerly was equipped with an electrified, 90-ton, gravity-flotation mill and a mine plant rated at 100 tons a day. Electric energy was supplied by a Montana Power Co. stub extending westward from the Radersburg substation. Development is by a two-compartment inclined shaft 550 feet deep with five levels aggregating about 10,000 feet (fig. 5). In 1949 these workings were flooded to a point 50 feet below the shaft collar. The mine and mill plants have been dismantled.

The Ohio-Keating vein is a persistent fracture filling in pyritized and intensely bleached andesite. It has been explored by underground workings along a horizontal range of 1,600 feet and over a vertical interval of 630 feet. The vein strikes N. 23° W. and dips 70° to 85° SW. It ranges from 1 to 5 feet in width; its average width is about 2 feet. Company records indicate that the intensity of mineralization along the vein structure is fairly consistent. The metal content of the ores, however, is spotty. About 40 percent of the ore developed by underground workings remains unmined.

The predominant vein minerals are auriferous pyrite and quartz with sparse copper sulfides. These are contained in a silicified andesite gangue. Production records indicate that the average recovered gold content of the ore in 1926 was 0.14 ounce a ton. In 1935 an average of 1.30 ounces gold a ton was recovered. The average recovered grade of all ores produced during the period 1901-45 was 0.31 ounce gold a ton (5).

Ruby (Pb-Zn-Ag)

The Ruby mine (fig. 3) is 10-1/2 miles over unimproved mine roads southwest from Radersburg. According to Stone (3), this property was an important producer of oxidized silver-lead ores prior to 1901. The mine has been operated sporadically at small scale since 1917. In 1944 production was stimulated by the acceptance of oxidized zinc ores at the International smelter in Utah; peak annual output was attained in 1945. The operation was inactive in 1949 with the exception of minor repair work.

The deposit has been developed by two closely spaced inclined shafts enlarged by stoping. In 1949 these workings were in poor condition. One shaft is equipped with a small gasoline-powered hoist and a 105-cubic foot gasoline-driven compressor. The underground workings explore the deposit along a horizontal distance of 150 feet and over a vertical interval of 170 feet (fig. 6).

The deposit is a flattened, pipe-shaped replacement in Madison limestone on the east limb of a north-trending anticline. The enclosing limestone beds, about 600 feet stratigraphically below the Quadrant quartzite formation, strike N. 7° E. and dip 40° to 45° SE. The long axis of the ore shoot appears to strike about N. 35° E. It ranges from 10 feet to 30 feet in thickness.

The principal vein minerals are smithsonite and cerussite with occasional sulfide cores contained in a siliceous gangue accompanied by calcite. The average recovered metal content from all ores produced from 1901 to 1948 was 4.4 percent lead, 8.8 percent zinc, and 5 ounces silver a ton (5).

Santa Anita (Ag-Pb)

The Santa Anita prospect is 1,700 feet south of the Jo Dandy mine (fig. 3). Its sporadic, small-scale operation has contributed relatively minor amounts of lead and silver to the county's metal output since 1910.

The deposit has been explored and developed by a single adit, a shallow winze, and a raise to surface. In 1949 the winze had been advanced to a depth of 30 feet below the adit level. Total underground development is estimated to aggregate about 900 feet, all in good condition. The workings have a horizontal extent of 350 feet and a vertical range of about 150 feet. Equipment includes an Ingersoll-Rand 210-cubic foot compressor powered by a Buda gasoline engine.

The mine workings explore a narrow, persistent, fracture filling vein striking N. 80° W. and dipping 73° SW. This structure, ranging from 4 inches to 18 inches in width, is enclosed by quartzites of the Quadrant formation, which strike N. 35° E. and dip 42° SE. At the Santa Anita, as well as the Jo Dandy and Jo Jo properties, these quartzites are on the east limb of a north-trending anticline.

The predominant vein minerals are limonite, cerussite, pyrolusite, and smithsonite in a siliceous gangue. Galena and sphalerite are found occasionally. According to production records, the recovered metal content of these ores has average 23 percent lead, 0.02 ounce gold, and 5.7 ounces silver a ton. An average of 1.3 percent zinc was recovered from ore shipped since 1946 (5).

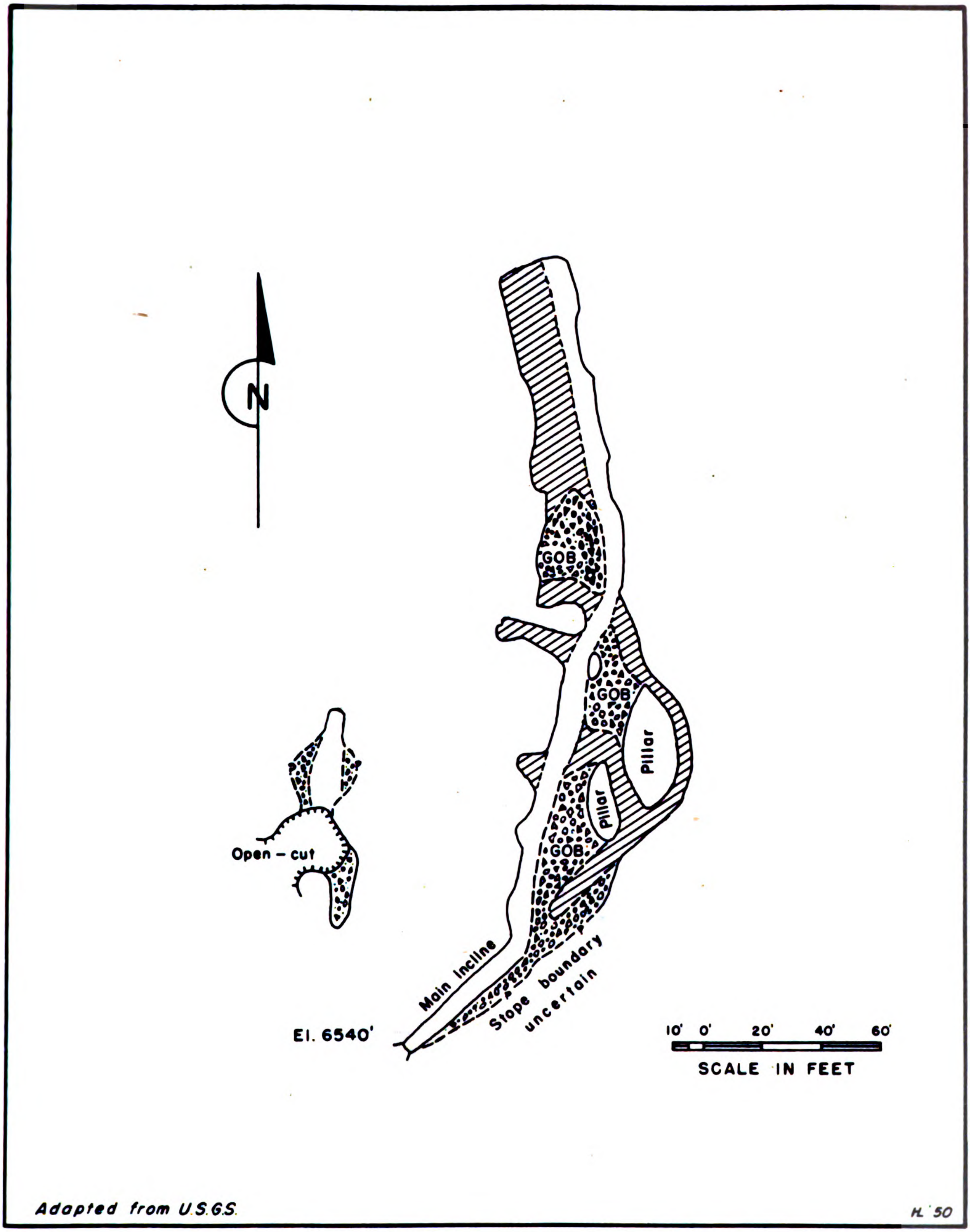
Spar (Ag)

The Spar mine (fig. 3) is at the head of Johnny Gulch at an altitude of 6,500 feet. Although the property is just over the border in Jefferson County, the only outlet for ores produced is by way of Radersburg and Toston. A brief description of the deposit, therefore, is included in this report.

The lode was exploited at small scale for several years after its discovery in 1890. Available records show that the property was dormant from 1901 to 1933. Small-scale operation, resumed in 1934, has been carried on sporadically to the present time by a succession of leasing groups. Winter access difficulties have retarded exploitation to a considerable degree.

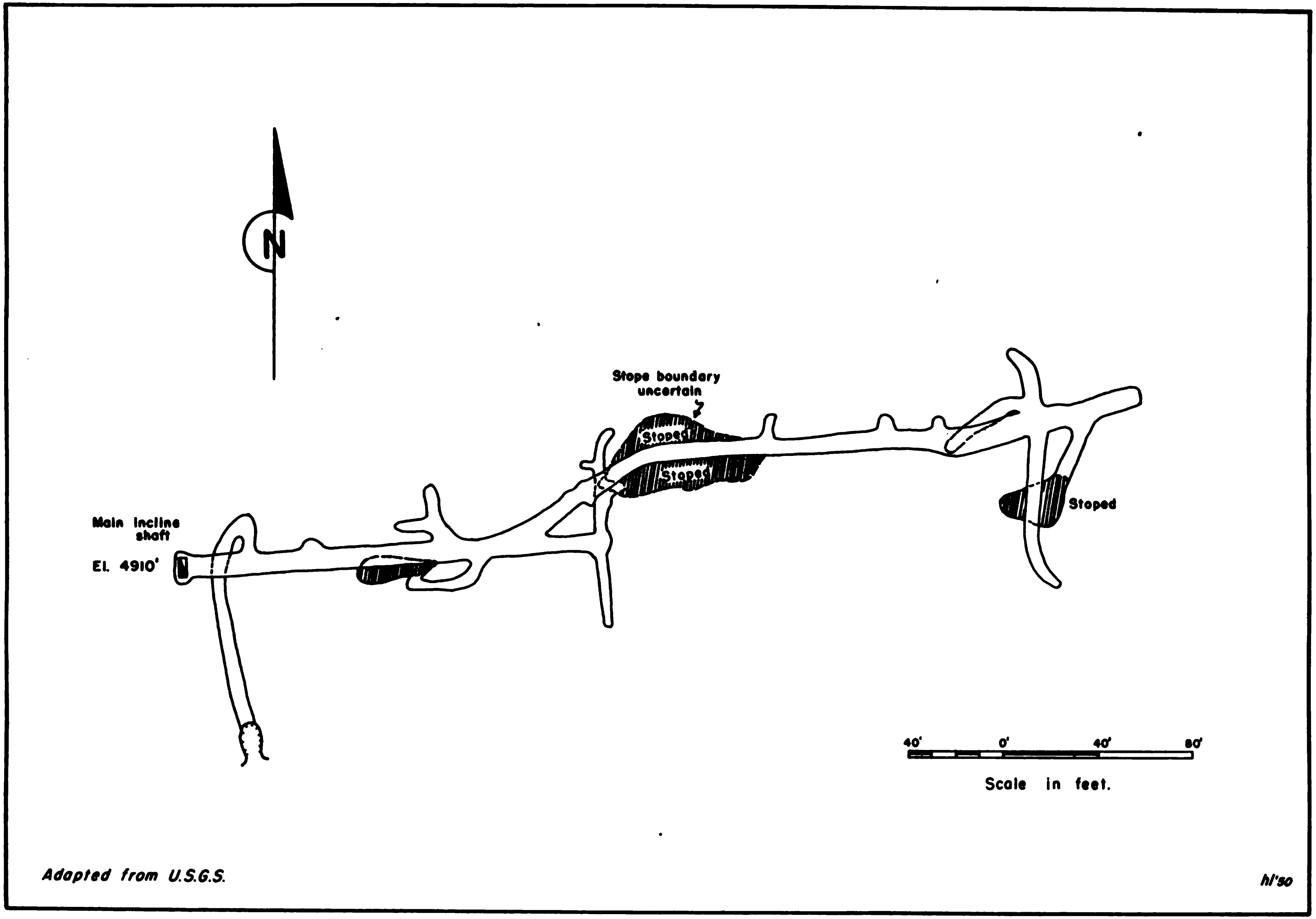
Development is by a flat-dipping incline enlarged by stoping (fig. 7). A gasoline-driven Ingersoll-Rand 105-cubic foot compressor provides power for rock drills and a small slusher hoist used for loading. A gasoline-powered tugger is used for hoisting in the incline.

The deposit is a bedding replacement in Jefferson limestone apparently localized in part by a steep-dipping fault of small displacement. The enclosing limestone beds, striking about N. 15° W. and dipping 30° NE., are at or near the axis of a north-trending anticline. The ore shoot is a flattened pipe 30 to 60 feet long and 1 foot to 3-1/2 feet wide. This pipe plunges northward with the enclosing limestones.



Adapted from U.S.G.S.

Figure 7. - Plan of Spar mine workings, Radersburg region, Jefferson County, Mont.



Adapted from U.S.G.S.

hl'50

Figure 8. - Plan of Summit mine workings, Radersburg region, Broadwater County, Mont.

The principal vein minerals are tetrahedrite, argentite, pyrolusite, and occasional specks of cerargyrite in a gangue containing barite, calcite, and quartz. According to production records, the recovered metal content has average 0.038 ounce gold, 22.6 ounces silver a ton, and 1.2 percent zinc (5).

Summit (Montana Silver Star)(Ag-Pb-Zn)

The Summit mine is in sec. 17, T. 4 N., R.1W., at an altitude of 5,000 feet. Although the deposit was discovered in 1887, its development has been retarded by the limited market for oxidized lead-zinc ores. After a small output in 1948, the operation was suspended, and all equipment other than a gasoline-powered hoist was removed. The deposit is opened by a two-compartment inclined shaft 600 feet deep (fig. 8).

A flattened, pipelike bedding replacement and fracture filling in massive Madison limestone has been explored by the shaft opening. The enclosing beds on the east limb of a north-trending anticline have been crumpled into a small southeast-plunging fold. The ore shoot apparently is localized by this secondary structure. The mineralized zone strikes northward, dips from 52° to 60° E, and ranges from 1 to 20 feet in thickness.

The predominant vein minerals are limonite, cerussite, and smithsonite, together with sparse copper and manganese oxides. These minerals are contained in a brecciated limestone gangue cemented by calcite and quartz. Production records indicate that the recovered metal content of the ore has averaged 0.1 percent copper, 10.6 percent lead, 2.5 percent zinc, 0.03 ounce gold, and 8.5 ounces silver a ton (5).

A composite of samples taken by the Bureau of Mines contained 10.4 percent lead, 15.4 percent zinc, 0.05 ounce gold, and 9.9 ounces silver a ton. Metallurgical tests by the Bureau of Mines gave a good recovery of lead and silver by flotation but indicated that treatment by the Waelz process would be required for zinc recovery. The ore responded favorably to Waelz process tests.

Other Mining Properties

A number of other mining properties were examined in the Radersburg region. In most instances, the underground workings were inaccessible; local information concerning their history and output was meager. Information concerning the structure, mineral associations, and enclosing rock types at these properties is summarized in table 9.

Confederate Region

Location and Access

The Confederate mining region is on the lower west slope of the Belt Mountains along the northeast extremity of Broadwater County. It may be reached by way of Canyon Ferry over 24 miles of maintained county and Forest Service roads from Clasoil on U. S. Highway 10 N. An alternate route connecting the Confederate region with Townsend, Mont., is over 21 miles of maintained county roads northwest through Canton.

TABLE 9. - Information on other mining properties in the Radersburg region, Broadwater County, Mont.

Property, location, and principal metal	Enclosing rock and structure	Strike and dip	Minerals	Indicated grade	Production	Remarks
Jebro Sec.12, T.5N., R.1W. (Au)	Shale and altered andesite. Mineralization along contact.	S 45° E Steep	Auriferous pyrite, limonite. Some magnetite	-------------	Prospect stage only	Shallow prospect shaft. Flooded 20 feet below collar.
Kahoka Sec.15, T.5N., R.1W. (Au)	Andesite. Narrow fracture.	N 16° W 72° SW	Limonite, scant auriferous pyrite, some malachite quartz gangue, sparse tactites	Local reports: 1 to 3 oz. Au	Small	70-foot vertical shaft sunk on narrow vein. Gold-bearing ores confined to widths ranging from 1 to 2 inches.
Last Hour Sec.18, T.6N., R.1W. (Cu)	Madison limestone. Narrow fracture.	S 20° E 40° NE	Oxidized copper minerals in limestone	Owner reports up to 20% Cu	None	Prospect adit only. Active in 1944. Schram 105 gasoline-powered compressor.
Mighty Monarch Sec.29, T.6N., R.1W. (Au)	Quartzite granite contact. Pipe-shaped replacement at contact.	N 25° W Steep	Native gold in calcite-garnet gangue. Some mica and rhodonite	Locally reported to have averaged $100 a ton	$10,000	Opened by shallow shaft and short adit driven under bottom of ore shoot. Cross section area of pipe reported to be about 140 square feet.
Monterey Sec.35, T.5N., R.1W. (Fe)	Andesite. Irregular contact. Metamorphic.	Not evident from accessible exposures	Magnetite with hematite, pyrite, garnet, and quartz Some copper oxides	Est. 35% Fe small amounts Au and Ag reported	Unknown, evidently small	Inaccessible. Formerly opened by 2 shallow shafts and 1 short adit. Mineralogy indicates that calcareous sedimentary rocks underlay the andesites at comparatively shallow depths.
North Butte Sec. 7, T.5N., R.1E. (Au)	Porphyritic andesite. Steep-dipping fracture.	N 15° W 81° SW	Limonite, scant MnO_2 in calcite gangue	-------------	Unknown, evidently small	Opened by shallow shaft flooded 30 feet below collar. Andesite walls intensely altered. Structure ranges from 4 to 8 feet.
Rena Sec. 7, T.5N., R.1E. (Au, Ag, Pb)	Bleached and silicified andesite. Fracture filling and replacement.	N 12° W 80° SW	Auriferous pyrite, scant galena, sphalerite, chalcopyrite and arsenopyrite; limonite-stained gangue	-------------	Unknown	Structure 3 feet wide at surface. Opened by 550-foot shaft (inaccessible). Horizontal extent indicated by surface exposures estimated at 400 feet. Idle since early 1900's.
Rothfuss Copper Sec. 9, T.5N., R.1W. (Cu)	Thin-bedded shaly limestone and andesite. Contact replacement near monzonite stock.	N 20° E 64° SE	Pyrite, copper sulfides, malachite, and pyrolusite in complex tactitic gangue	-------------	Small	Shallow inclines develop 2 sub-parallel veins 3 to 6 feet wide separated by 25 feet of garnetized shaly limestone. Some of ore contains native gold. Property idle and unequipped in 1949.
Rothfuss Iron Sec.19, T.5N., R.1W. (Fe)	Cambrian limestone intruded by diorite dikes. Replacement along fracture zone.	N 20° W ---------	Magnetite with sparse copper oxides and 1-inch quartz veins	0.05-0.8% S, 0.03-0.05% P, 52-59% Fe	75,000 tons	Material shipped to Anaconda smelter for flux during period 1908-10. Reported to contain up to $1.50/ton gold and 1 ounce silver/ton. Indicated length about 600 feet. Vertical range is 200 feet. Developed by adits aggregating 1,000 feet (inaccessible) and several open cuts.
Sadie S Sec.28, T.6N., R.1W. (Au)	Thin-bedded calcareous shales. Contact replacement near small granite plug.	Uncertain, not evident from accessible exposures	Native gold with limonite, pyrite and garnet	Reported: $5 to $100 a ton. Ore mainly in pockets.	Less than $50,000	Topography suggests deposit localized along north-striking fault. Dumps reported to contain $12/ton were milled for short period. Mill has been dismantled; mine workings are inaccessible.

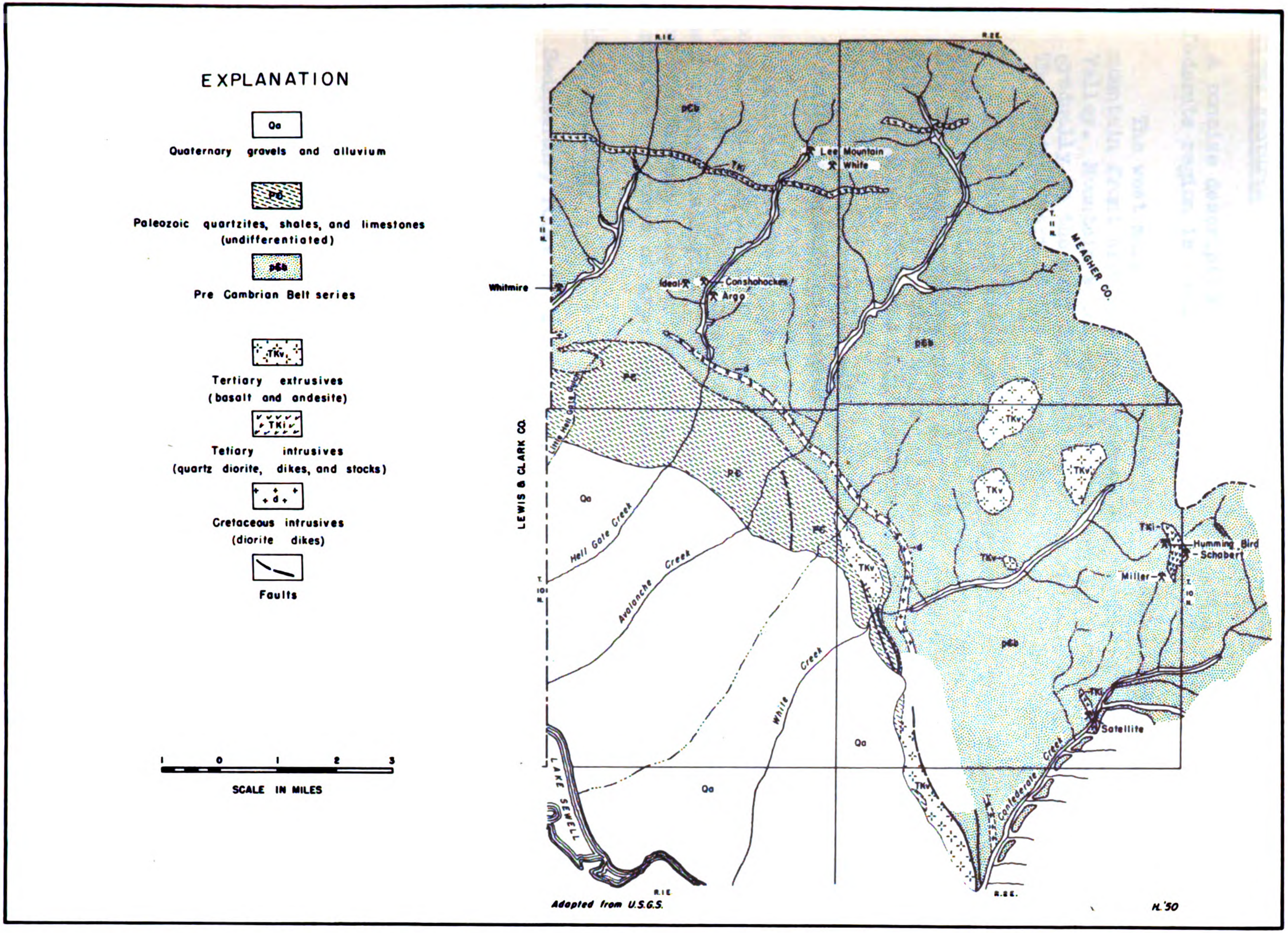


Figure 9. - Geologic map of the Confederate region, Broadwater County, Mont.

Physical Features

A concise description (2) of the main topographic features in the Confederate region is abstracted as follows;

> The west margin of the region is marked by a wall-like mountain front abruptly rising above the benchlands of Townsend Valley. Mountain spurs extending northwest from this front rise gradually to the main divide at an altitude of about 7,000 feet. The central part of the mountains is a broad plateau-like area.***
>
> The southwest slope of the Belt Mountains is drained by several deep valleys, all of which, except Confederate Gulch, are steep and gorgelike where they notch the mountain front. Confederate Gulch is a wide valley of moderate gradient and without any gorgelike stretches comparable to its neighbors.

The valleys are supplied with abundant water by both the main streams and tributaries as well as numerous springs.

About half of the region is timbered with dense stands of pine and fir generally suitable for mine support. The forested north slopes at the higher altitudes contain timber of commercial grade. At the lower altitudes, the forest cover thins rapidly and is replaced partly by scattered clumps of cedar and juniper. Some of the upland parks and most of the stream courses are marked by groves of aspen and cottonwood.

Geologic Setting

Sedimentary rocks in the Confederate region range from the Algonkian Belt series to the Permian Phosphoria formation. Jurassic and Cretaceous formations exposed at Radersburg apparently are buried in the Confederate region by Oligocene and Miocene beds. Plesitocene gravels cover the benches flanking the main drainage channels and the terraces skirting the mountain front (fig. 9).

The region's extrusive rocks are limited to a few comparatively small areas of andesite and basalt centered about 4 miles northwest from the former site of Diamond City. According to Pardee (2), the andesites are of middle or late Tertiary and early Quaternary age. The basalt evidently is younger than Miocene.

The principal intrusive rocks include dikes, sills, and stocks of both diorite and quartz-diorite. A persistent group of diorite sills and dikes intruded near the top of the Belt shales extends from Confederate Gulch westward beyond the county border. These intrusives most commonly follow the steeply inclined bedding of the enclosing strata, although a few cut the sedimentary layers. The bodies are several miles long and range from 200 to 500 feet in width.

A system of steep-dipping quartz-diorite dikes cutting the Newland formation crops out along margin of the Confederate region. Members of this system are 400 feet wide and range from 2 to 4 miles in length.

Several quartz-diorite stocks crop out in Confederate Gulch below its confluence with Boulder Creek, at the head of Montana Gulch, and near the head of Cement Gulch. Gold-quartz lodes associated with these stocks presumably were the source of the placer gold found along the Confederate Creek drainage.

The region's dominant structural feature is a broad northwest-trending anticline bounded by overthrusts on the southwest and northeast. At Avalanche Gulch, this arch is symmetrical. In White Gulch several secondary folds have developed on the northeast limb. The anticline finally loses its identity at Confederate Gulch in a group of smaller folds. Paleozoic formations bordering the anticline along the mountain front on the southwest are complexly folded and dislocated by overthrusting along the El Dorado fault. All of the known lodes in the Confederate region occupy tension fractures presumably originated by stresses developed along this fault.

Wall rock alteration is not pronounced in the Confederate region. Quartz-diorite associated with most of the gold-bearing lodes usually is intensely silicified. Occasionally, the argillites enclosing some of the copper lodes are chloritized. Pyritization apparently is not widespread as at Radersburg.

Gold is the principal metal recovered from the Confederate lodes. These deposits generally are small, shallow, and erratic in grade. Few have been developed beyond a depth of 150 feet. a number of copper-bearing lodes have been prospected to shallow depths. Only one of these lodes, the Argo, has produced a significant amount of metal.

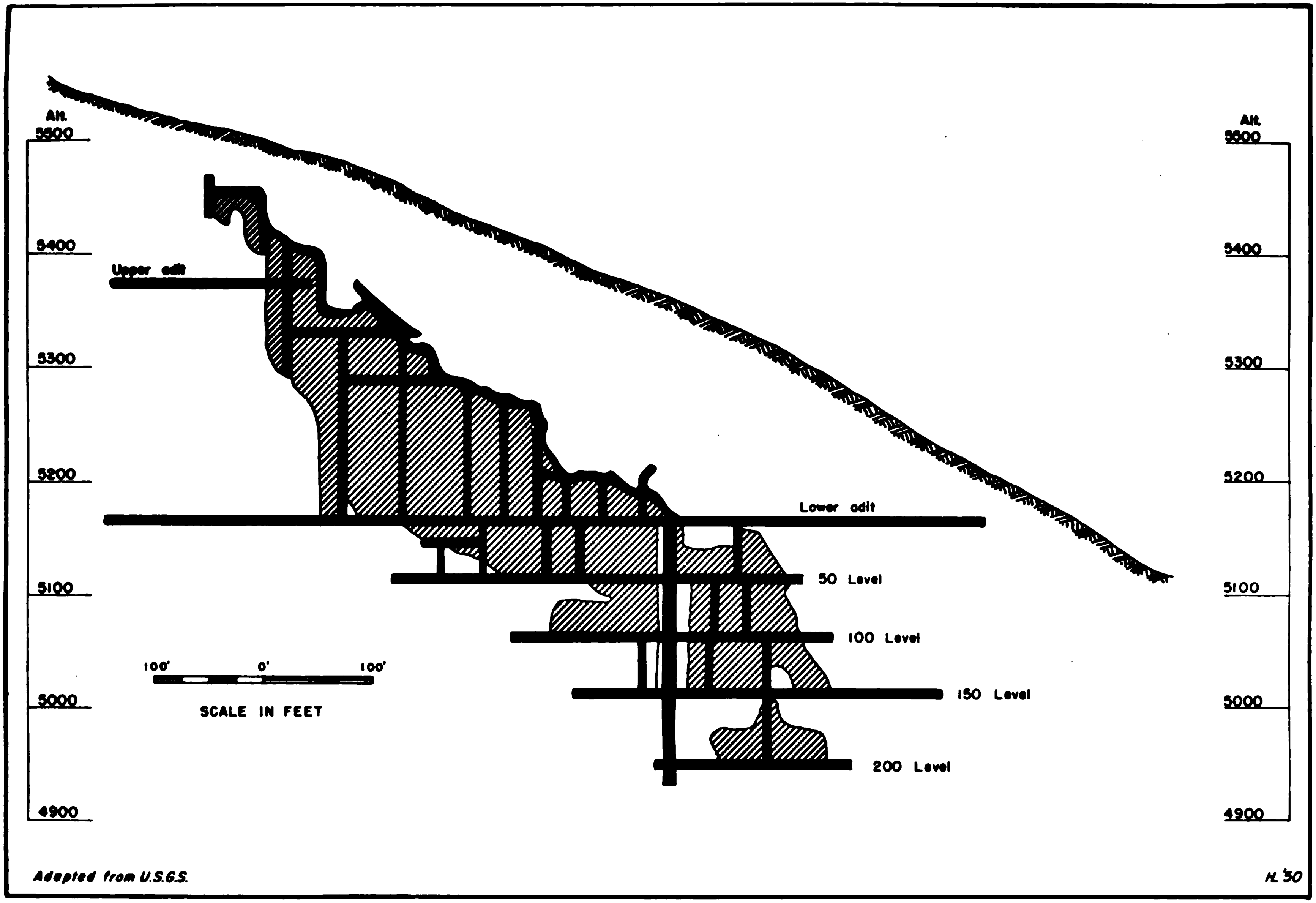
Argo (Eclipse-Argo)(Cu)

The Argo mine (fig. 9) is in Hellgate Gulch at an altitude of 5,800 feet. The lode was discovered before 1900 and was sporadically exploited during the period 1902-26. Surface plant buildings including a former 50-ton electrified concentrator are in ruins; all equipment has been removed. The underground workings, aggregating several thousand feet in length, were inaccessible in 1949.

The lode is a fracture filling and replacement in thin-bedded, green argillites of the spokane formation. It strikes N. 70° E., dips steeply northwest, and ranges from 4 to 5 feet in width (2). Development is by adit, winzes, and intermediate levels, which extend along a horizontal range of 700 feet and over a vertical interval of 600 feet (fig. 10).

The ore bodies ranged from 6 inches to more than 2 feet in width. One ore shoot in the lower workings is reported (2) to have consisted mainly of chalcopyrite ranging to 18 inches in width. This ore shoot had a pitch length of several hundred feet. Crude ore mined from this shoot contained 26 percent copper.

The vein minerals are chalcopyrite, sparse chalcocite, ankerite, and quartz. The oxidized ores are chiefly limonite, malachite, and chrysocolla accompanied by quartz. Production records indicate that the recovered metal content of the ore averaged 6.5 percent copper.



Adapted from U.S.G.S.

Figure 10. - Longitudinal section of the Argo mine, Confederate region, Broadwater County, Mont.

Humming Bird (Au)

The Humming Bird claim (fig. 9) is at the head of Johnny Gulch. It is reported to have produced rich gold-quartz ores in 1917 and 1918. Available production records, however, indicate only sporadic, small-scale operation from 1932 to 1935.

The property has been explored by two short adits and several small open cuts along a horizontal range of 400 feet and over a vertical interval of 250 feet. The adits were inaccessible in 1949.

Surface exposures show the deposit to be a bedding replacement and fracture filling in Newland shales near a small quartz-diorite stock. The lode strikes N. 30° E., dips 85 NW., and ranges from 4 inches to 18 inches in width. The vein minerals are pyrite, limonite, and sparse chalcopyrite in a drusy quartz gangue. Production records indicate the recovered metal content of the ore averaged 1.25 ounces gold and 1.7 ounces silver a ton (5).

Miller (Slim Jim) (Au)

The Miller claims (fig. 9) are at the head of Greenhorn Gulch at an altitude of 6,400 feet. Since discovery in 1900, the property has been a consistent, small-scale producer of rich gold-quartz ores. It is developed by three main adits, connecting raises, and several flat winzes along a horizontal distance of 600 feet and over a vertical interval of 300 feet. The workings, aggregating several thousand feet, are all in fair condition. The mine is equipped with a gasoline-powered Ingersoll-Rand compressor. Ores are concentrated at the rate of 1 ton per shift in a single-stamp amalgamating mill driven by a 2-horsepower gasoline engine.

The lode is a narrow zone of irregular quartz veinlets extending along a contact between thin-bedded Newland shales and a small quartz-diorite stock. This lode strikes about N. 35° E., dips 20° NW., and ranges from 1 to 4 feet in width. The quartz-diorite is intensely altered and silicified.

The quartz veinlets commonly extend from the contact into the shales along bedding planes and into the intrusive. Native gold occasionally is found in the quartz-diorite and in the shale. Most of the gold, however, has been recovered from the quartz veinlets on the contact. Pyrite is the most conspicuous vein mineral although occasional crystals of chalcopyrite, galena, sphalerite, and rhodochrosite are present.

The ore is highly erratic in tenor. In 1909 the mine produced 3 tons of ore averaging 151 ounces gold a ton. In 1947 a single "nugget" valued at $2,200 was recovered. The recovered metal content of ores produced since 1901 averaged 7.95 ounces gold and 4.6 ounces silver a ton (5).

Satellite (Baker)(Au)

The Satellite claim (fig. 9) is at the confluence of Confederate and Boulder Creeks. This property, together with several adjoining claims, evidently was active before 1901. Production records, however, show no output prior to 1926. In the summer of 1949, one of the old prospect adits was reopened and sampled. Reliable information concerning this property's history or early output is not available.

The deposit is a quartz lode system 3 to 8 feet wide in thin-bedded Newland shales adjoining a small quartz-diorite stock. This lode is partly exposed by the prospect adit over a horizontal distance of 300 feet. Its vertical range, indicated by caved adits near the creek level and by surface cuts, is more than 400 feet. The numerous lenses and stringers comprising the lode strike about N. 20° W. and dip 33° to 55° SW., closely coinciding with the bedding of the enclosing shales.

The predominant vein minerals are pyrite, limonite, and scattered crystals of galena, accompanied by massive, milky white quartz. Nearly identical vein material was found on several dumps marking inaccessible workings in the vicinity. According to production records, the recovered metal content of the Satelite ores averaged 0.9 percent lead, 0.55 ounce gold, and 1.1 ounces silver a ton (5).

Other Mining Properties

A summary of available information concerning additional deposits inspected in the Confederate region is given in table 10. In most instances, history and output are unknown.

Winston Region

Location and Access

The Winston mining region is 21 miles southeast of Helena, Mont. Access is westward from Winston, Mont., on U. S. Highway 10N by maintained county roads along Beaver and Weasel Creeks. Winston (population 80) is a mining community and shipping point on the Logan-Helena spur of the Northern Pacific Railroad.

Physical Features

The region is a moderately rugged area of about 25 square miles on the east slope of the Elkhorn Range. Altitudes range from 4,350 feet at Winston to 7,400 feet at the Vossburg mine. The Elkhorn Divide at the southwest is about 8,300 feet above sea level.

Drainage is to the northeast by Beaver Creek and its tributary, Weasel Creek, into the Missouri River. These streams have gradients ranging from 250 feet to 400 feet per mile.

The benchlands and low hills bordering the Missouri River Valley are treeless. Dense stands of lodgepole pine and fir at the higher altitudes constitute an abundant reserve of timber suitable for mine support.

Geologic Setting

The Winston region is underlain principally by andesite flows, tuffs, and breccias (fig. 11). The extrusive rocks have been invaded by eight or more small quartz-monzonite stocks disposed along a zone about 4 miles wide. These bodies are members of the intrusive chain that extends northward from Radersburg to Canyon Ferry.

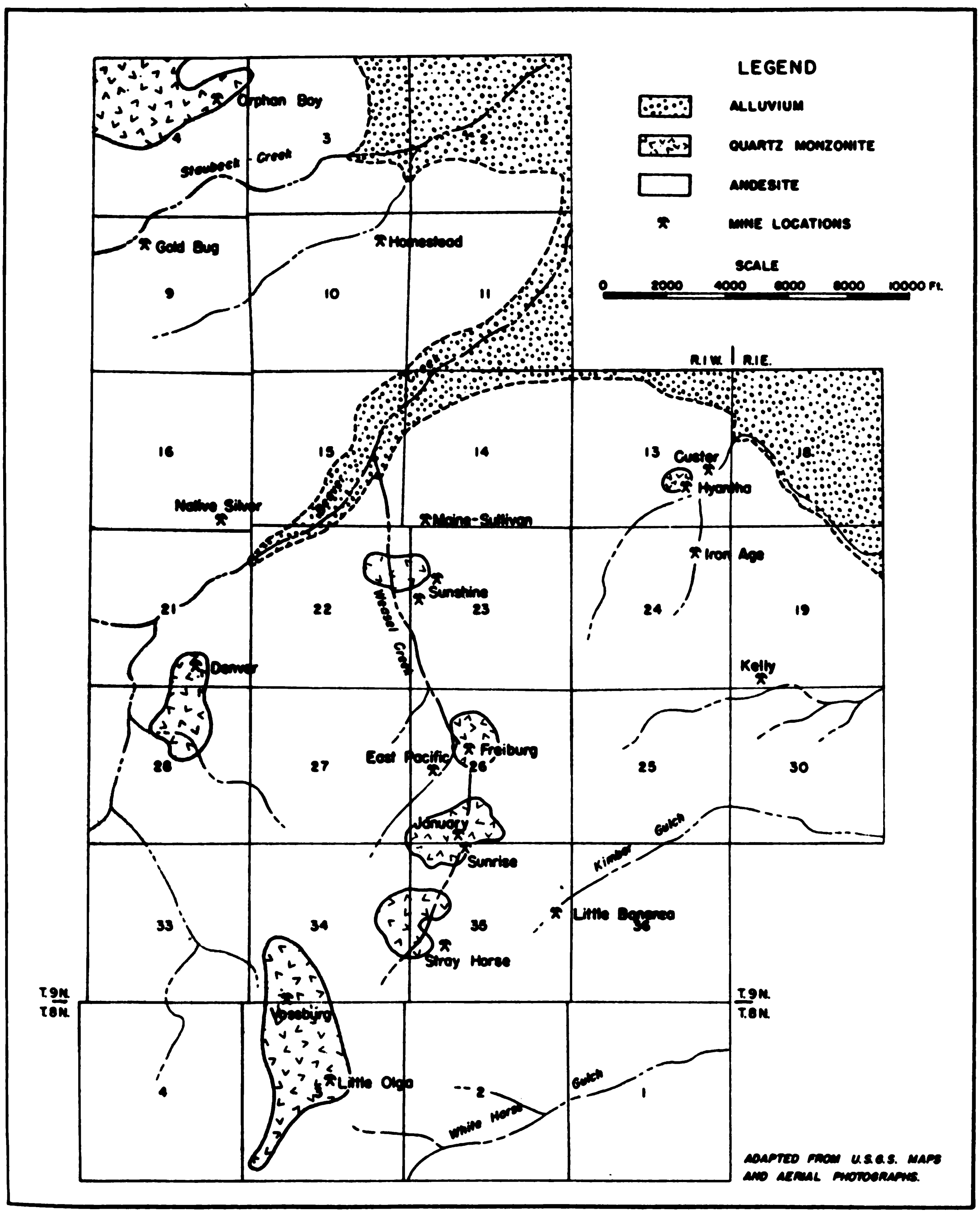


Figure II. - Geologic map of the Winston region, Broadwater County, Mont.

TABLE 10. - Information on other mining properties in the Confederate region, Broadwater County, Mont.

Property, location, and principal metal	Enclosing rock and structure	Strike and dip	Minerals	Indicated grade	Production	Remarks
Conshohocken, Sec.22,T.11N.,R.1E (Cu)	Greyson argillite. 2 parallel veins, 3 ft. wide, about 100ft. apart	N60°E. 80°NW	Chalcopyrite, secondary chalcocite, accompanied by ankerite in quartz	Low	Unknown	Prospect opened by two short adits (inaccessible) and several shallow cuts.
Ideal Sec.22,T.11N.,R.1E (Cu)	Greyson argillite. Narrow fracture filling.	N65°E. steeply north	Chalcopyrite, ankerite in drusy quartz gangue.	Low	None	Prospect only. Opened by shaft and lower adit (both inaccessible). Structure exposed by several trenches.
Lee Mountain Sec.12,T.11N.,R.1E. (Pb-Zn)	Newland shales. Narrow fracture filling 3 ft. wide.	N30°W steeply north	Pyrite, galena some sphalerite in quartz-ankerite gangue	Low	None	Prospect only. Opened by two short adits, both inaccessible.
Schabert Sec.18,T.10N.,R.3E (Au-Ag)	Quartz diorite. Narrow fracture filling, joints in wall rock also filled by quartz veinlets	N20°E. 75°SE	Pyrite, native gold, sparse galena in quartz gangue.	Erratic $1 to $500 in Au and Ag	Unknown	Five or more veins developed by shallow adits, all inaccessible. Quartz-diorite wall rock reported to contain small amounts of gold.
White Sec.12,T.11N.,R.1E. (Au-Ag)	Newland argillite in contact with quartz diorite. Replacement along shear zone about 5 ft. wide	N45°W. 70°NE	Pyrite, scant galena and cerussite in drusy quartz gangue.	Character sample contained 0.7 oz. Au and 1.8 oz. Ag/ton	None	Opened by two short adits. Prospect only.
Whitemire Sec.29,T.11N.,R.1E. (Cu)	Greyson shale. Fracture fill and replacement up to 3 ft. wide.	N45°E 50°NW	Chalcopyrite, limonite, scant chalcocite in quartz gangue.	Picked ore 17% Cu	16-ton test shipment	Vein exposed by short adit, open-cuts, and test pits over a strike length of 750 feet.

The andesites are marked by a prominent joint system and occasionally by flow banding. They range in color from light to dark gray and greenish-black. At the intrusive contacts they usually weather to shades of buff or rusty brown. Most of the andesites are porphyritic; some are entirely without phenocrysts.

The quartz-monzonite is a gray, coarse-grained rock commonly marked by several joint sets and large feldspar phenocrysts. Near the Vossburg mine and at the Orphan group, individual feldspar crystals are more than 1 inch long.

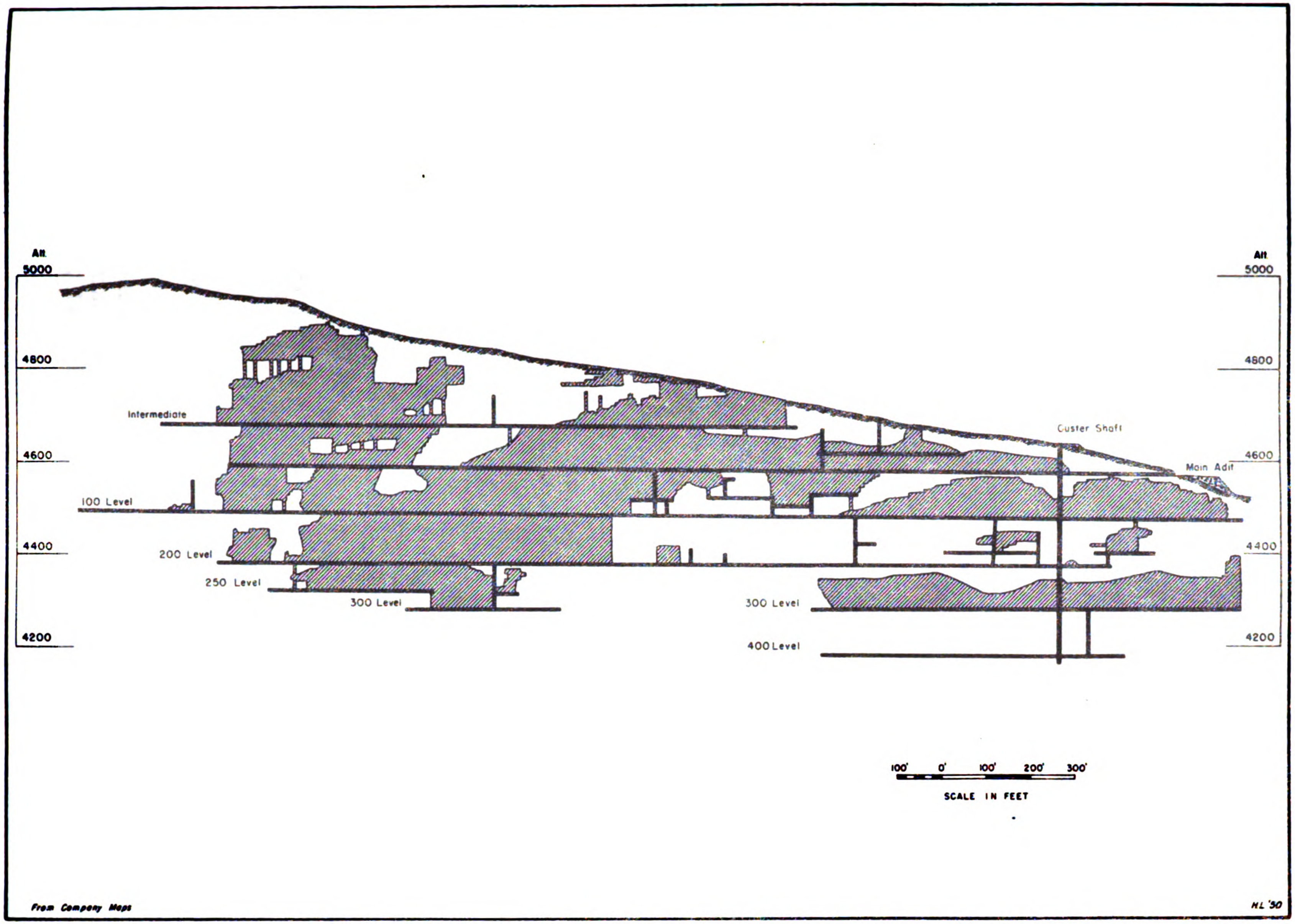
Faulting other than that exposed by underground workings is not easily identified in the Winston region. Detailed studies of aerial photographs supplemented by field observations, however, suggest the existence of several major, northwest-trending crustal breaks apparently belonging to the fault series identified in the Radersburg and Indian Creek regions. Inasmuch as the veins throughout the Winston region strike eastward or nearly so, they apparently are tension fractures formed by force components developed along the northwesterly faults. Postore faulting is neither widespread nor important. A few lodes are offset, rarely more than several feet, by such faults. The flat-dipping veins at the Iron Age and Custer mines have been broken repeatedly by a series of steep-dipping step faults. No vertical displacement greater than 3 feet was observed.

The monzonite and andesites have been hydrothermally altered along most of the vein fractures. However, pronounced alteration effects rarely extend more than a few feet into the wall rock. The most intense alteration apparently occurs along lodes in monzonite. At the Little Olga (Kleinschmidt) mine, the enclosing monzonite is sericitized to 4 feet on each side of the vein structure. In contrast, development along a similar lode at the Vossburg mine exposes a vein welded to unaltered quartz-monzonite walls. The alteration of andesite wall rock commonly is marked by bleaching, silicification, and pyritization. Typical alteration halos adjoining lodes in andesite are narrow; they seldom extend more than 18 inches beyond the vein structure.

The lodes in the Winston region are narrow, steep-dipping fracture fillings developed principally for their gold content. They are characterized by a quartz gangue accompanied by small amounts of pyrite. On depletion of the rich oxidized portions of the ore shoots, continued development at some of the lodes disclosed profitable amounts of lead-silver and lead-zinc ores. Most of the lodes contain small amounts of copper associated with the other sulfides. No deposits valuable mainly for their copper content have been found.

Buzz (Au)

The Buzz prospect is in sec. 31, T.9N., R.1W., 7 miles northwest from Winston over county roads and timber trails. According to local accounts, production since discovery in 1891 has amounted to about $60,000. Development, estimated to aggregate 3,000 feet, is by five adits and two shafts. Only a small part of some of these workings now is accessible. The property is unequipped except for a five-stamp, plate-amalgamating unit powered by a steam threshing tractor.



From Company Maps

HL '50

Figure 12. - Longitudinal section of the Custer mine, Winston region, Broadwater County, Mont.

A narrow sheeted zone in andesite is explored by the workings along a horizontal distance of 1,000 feet and over a vertical interval of 150 feet. The structure strikes N. 87° E., dips 45° SE., and ranges from 4 inches to 2 feet in width. The ore shoots are small, nonpersistent lenses of quartz disposed at irregular intervals along the sheeted zone.

A contact between andesite and quartz-monzonite at the portal of the lower adit is penetrated by the sheeted structure. There is, however, little evidence of mineralization in the monzonite. At one of the upper adits a number of small vertical stringers of granite are cut and offset several inches by lateral movement along the sheeted zone.

Auriferous pyrite and limonite in a milky quartz gangue are the predominant minerals. The ore is reported by local residents to range in value from $20 to $400 a ton in gold.

Custer-Iron Age-Hyantha (Au)

The Custer, Iron Age, and Hyantha groups (fig. 11) consist of 38 patented lode claims about 2 miles south from Winston. Local reports credit these properties with an aggregate output ranging from $700,000 to $1,500,000, most of it made between 1879 and 1901. These figures cannot be verified, as they precede the adoption of systematic county production records. Recent output has stemmed largely from the recovery of ore from waste dumps and from several small-scale "pocket-hunting" ventures.

Underground workings on the Custer group are said to aggregate 3 miles in length. Judging from the remaining dumps, the Iron Age workings apparently aggregate about the same. Most of the workings now are flooded or otherwise inaccessible. Only a few short adit openings currently maintained by prospectors may be entered. The electrified mine plants and mill formerly serving the Custer and Hyantha mines have been dismantled. All surface structures have been removed from the Iron Age property, with the exception of a small experimental amalgamating mill recently installed to treat material from the dumps.

The numerous veins in the area are in andesite near a small stock of quartz monzonite and aplite. Several veins occupy persistent fractures trending north to northwest and dipping westward. Other weaker veins are confined to bedding slips in the andesite.

The Custer workings develop a steep-dipping, narrow, fracture filling along a horizontal distance of 2,400 feet and over a vertical interval of 700 feet (fig. 12). This vein strikes N. 30° E., dips 62° NW., and ranges from 1 foot to 3 feet in width. A parallel vein 130 feet to the west has been explored on several levels by the Custer workings. This vein apparently was unproductive.

The Hyantha lode, about 1,700 feet south of the Custer shaft, has been developed by shaft workings to a reported depth of 500 feet. As exposed by surface raise openings, it strikes N. 70° E., dips vertically, and is about 2 feet wide.

Excepting the Hyantha, these lodes contain auriferous pyrite with minor amounts of galena, chalcopyrite, and molybdenite in a siliceous gangue. The richer ore is generally associated with honeycomb quartz. At the Hyantha mine, reputed to have produced lead-silver ores, fragments scattered over the waste dumps contain pyrite, galena, and sphalerite in a siliceous gangue.

The combined recovered metal content of ores reclaimed from waste dumps and output from the various prospects has averaged 0.6 percent lead, 0.23 ounce gold, and 0.8 ounce silver a ton (5). The small tonnage currently derived from prospecting ventures usually contains 1 ounce or more gold per ton.

East Pacific (Ag-Pb-Zn)

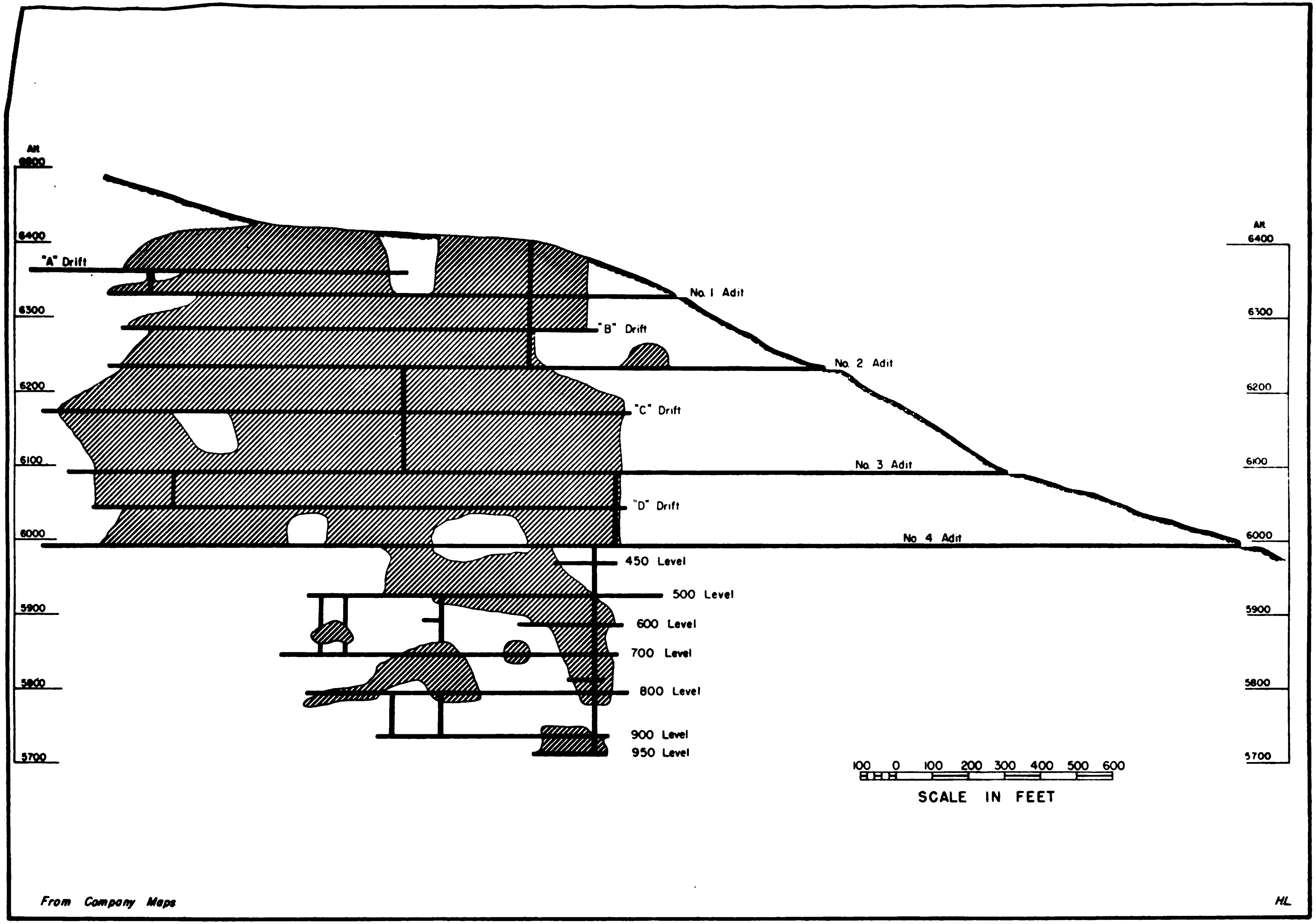
The East Pacific mine (fig. 11) occupies parts of secs. 26 and 27, T. 8 N., R. 1 W., along Weasel Creek. It has been exploited periodically since the early 80's by several companies and a number of leasing groups. Its estimated output exceeds $2,000,000. In 1949, underground operation was confined to rehabilitation work along the main adit. However, a substantial tonnage of ore was reclaimed from old dumps and concentrated in a company gravity plant. The operation is electrified and fully equipped for mining and milling at the rate of 100 tons per day.

Development is by several shafts, 4 main adits, a vertical winze, and 10 intermediate levels aggregating about 5 miles in length. These workings explore the vein along a horizontal range of 1,800 feet and over a vertical interval of 1,400 feet (fig. 13). In 1949 most of the No. 4 adit and part of the No. 3 adit workings were accessible. The winze and all levels below the No. 4 adit have been flooded since pumping was terminated in 1947. Pumping at the rate of 80 to 100 gallons a minute was necessary to keep the lower levels unwatered.

The vein is a persistent fracture filling in comparatively unaltered andesite. It strikes N. 75° E., dips 70° to 85° NW., and ranges from 1 inch to 5 feet in width. It generally has a banded texture and is completely devoid of gouge. In the No. 4 adit the vein is broken at several points by steep, eastward-trending faults. The horizontal displacement along these faults is to the right and rarely more than 5 feet.

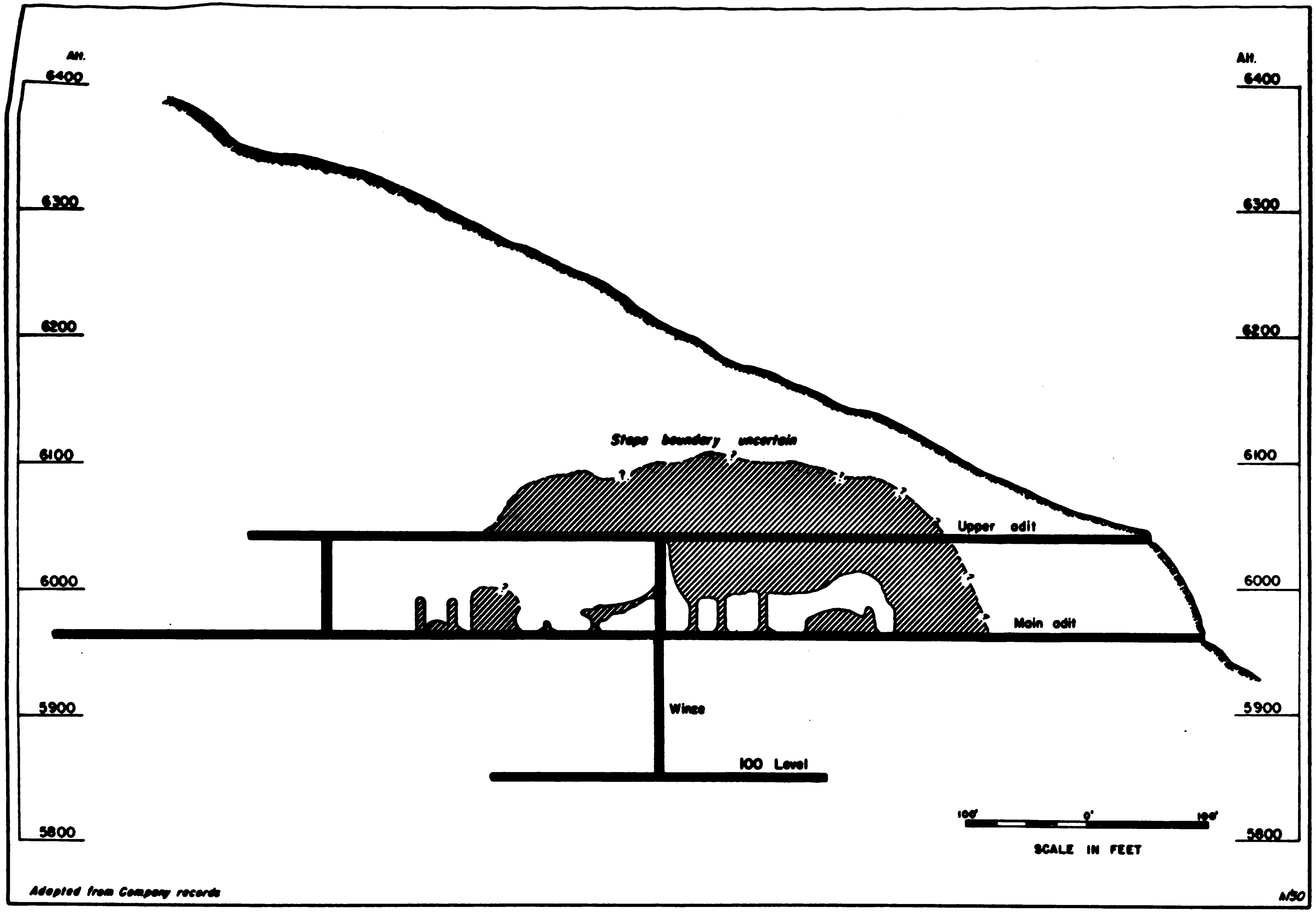
The enclosing andesite is a dark-gray rock, comparatively unaltered, and occasionally marked by flow-banding. It is broken by closely spaced sheeting fractures parallel to the vein structure.

The vein minerals are pyrite, galena, and sphalerite accompanied by chalcopyrite, tetrahedrite, and small amounts of native gold. Quartz, calcite, and occasional rhodochrosite are the predominant gangue minerals. Early production from the upper oxidized portion was relatively rich in gold. As mining advanced to the sulfide zone, the gold content dropped appreciably. In 1947, however, a 44-pound lot taken from the 900 level contained 100 ounces of gold. Production records indicate that the recovered metal content of all ores mined since 1900 has averaged 6.3 percent lead, 2.2 percent zinc, 10.2 ounces silver, and 0.29 ounce gold a ton (5).



From Company Maps

Figure 13. - Longitudinal section of the East Pacific mine, Winston region, Broadwater County, Mont.



Adapted from Company records

Figure 14. - Longitudinal section of the January mine, Winston region, Broadwater County, Mont.

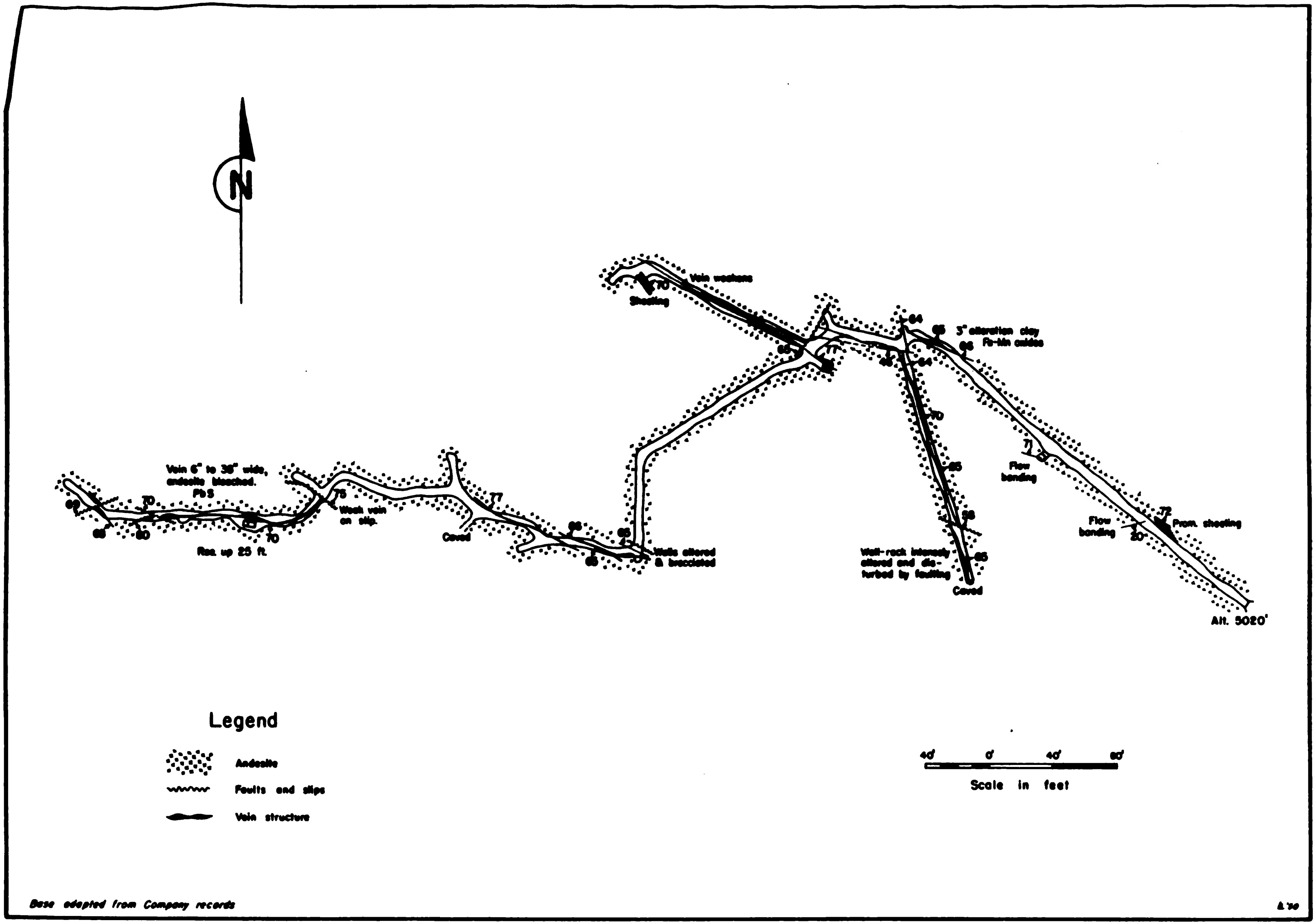


Figure 15. - Geologic plan of the Kelly mine, Winston region, Broadwater County, Mont.

January (Ag-Pb-Zn)

The January mine (fig. 11) is on Weasel Creek about 2,000 feet south of the East Pacific property. It has been exploited intermittently on a small scale since 1899. Most of the recorded output, however, was made in 1931. The underground workings (fig. 14), aggregating about 2,000 feet, were inaccessible in 1949. All equipment has been removed.

The workings explore a contact structure between quartz monzonite and andesite for a horizontal distance of 900 feet and over a vertical range of 260 feet. This structure strikes N. 75° W., dips 65° SW., and ranges from 5 to 9 feet in width. An underground exposure seen by Pardee (2) consisted of two bands 3 feet and 2 feet thick separated by 4 feet of country rock. At another exposure recently opened by road construction, the vein consists of a 4-foot monzonite core veined with quartz and bordered on both walls by alteration clay.

Ore fragments found in the waste dumps contain pyrite, galena, sphalerite, scant chalcopyrite, and traces of rhodochrosite in a siliceous gangue. The average recovered metal content of all ores produced during the period 1901-48 was 0.11 percent copper, 5.0 percent lead, 3.4 percent zinc, 5.3 ounces silver, and 0.108 ounce gold a ton (5).

Kelly (Ag-Pb)

The Kelly prospect (fig. 11) is at the base of the Elkhorn Range, about 3 miles south of Winston. Production, according to local reports, consisted of "six sacks of high-grade" ore taken from one of the adits in the early 1900's. In 1949 the property was reopened for a short period and a single test shipment was made.

The deposit has been prospected by several shallow shafts and three adits. These are inaccessible, with the exception of the lower adit workings, which aggregate about 1,300 feet (fig. 15). Two parallel shear veins in flow-banded andesite have been explored. These veins are about 160 feet apart; they strike N. 65° W., and dip 65° to 77° NE. Both are tight fractures ranging from 2 inches to 3 feet in width, accompanied by a small amount of gouge and narrow alteration halos. The north vein is displaced a few feet to the left at several points by postore slips. The south structure appears to be a series of echelon fractures of little strike persistence.

The vein minerals are pyrite, galena, cerussite, limonite, and sparse sphalerite. The gangue is quartz and altered andesite. Ore tenor of the south structure, as indicated by the 1949 test shipment, is as follows: 5.8 percent lead, 0.1 percent copper, 3.0 ounces silver, and 0.25 ounce gold a ton.

Little Bonanza (Ag-Pb-Zn)

The Little Bonanza mine (fig. 11) is at the head of Kimber Gulch. It was discovered and intermittently prospected in the 1890's. During this period an unknown but evidently small tonnage of lead-silver ore was produced. Sporadic operation between the years 1911-18 resulted in a small output. The property was reopened in 1947 and since has maintained a small annual output of rich lead-silver ores. It now is equipped for small-scale operation with a gasoline-powered, 210-cubic foot compressor.

Two adits connected by raises, together with a shallow prospect shaft, partly explore a steep, eastward-trending vein along a horizontal distance of 500 feet and over a vertical interval of 250 feet. The aggregate length of these workings is 1,300 feet (fig. 16). In 1949, only the lower adit was accessible.

The vein is a fracture filling in andesite striking N. 80° W. and dipping 60° to 75° NE. The ore shoots within this structure are comparatively small, lenticular bodies, which apparently thicken at the steep dips and pinch out at the flat dips. Their greatest width is 3 feet. The largest lens exposed during recent development had a stope length of about 30 feet. In one instance the vein structure has been offset about 15 feet to the right by faulting that bears northwesterly and dips steeply eastward. The vein minerals are galena, pyrite, and sphalerite with small amount of chalcopyrite. The gangue is largely quartz and brecciated andesite. According to production records, the recovered metal content of the ore shipped since 1900 averaged 37.7 percent lead, 2.8 percent zinc, 26 ounces silver, and 0.04 ounce gold a ton (5).

Little Olga (Kleinschmidt)(Ag-Pb-Zn)

The Little Olga group (fig. 11) consists of 11 patented lode claims on the divide between Weasel and Whitehorse Creeks. Several of the claims were active prior to 1900 and apparently contributed substantially to the county's metal output. Activities since 1900 have consisted chiefly of sporadic prospecting ventures. However, about 4,000 tons of ore was taken from the Little Olga workings in 1927 and 1928. During this period, a development adit was driven to reach the Little Olga vein at greater depth. In 1948 the Little Olga vein was explored from this adit by a short raise. A few tons of ore was shipped; the venture was abandoned in 1949.

Underground workings in the Little Olga group aggregate more than 9,000 feet in length. Currently accessible workings include the development adit and a 900-foot crosscut to the Little Olga vein from Whitehorse Gulch. The development adit is equipped with a 300-cubic foot compressor, battery locomotive, and ventilating fans. A Montana Power Co. transmission line has been extended to the adit portal.

The veins are narrow fractures in quartz monzonite containing lenticular ore shoots of moderate persistence. The most productive veins are steep, eastward-trending fractures containing occasional lenticular bodies of lead-zinc ores. A second group of veins striking northward and dipping west at low angles have produced gold ores.

The Little Olga vein is explored along a strike distance of 1,200 feet and over a vertical interval of 760 feet. As exposed by the development adit, this structure strikes N. 80° W., dips about 70° NE., and ranges from 4 inches to

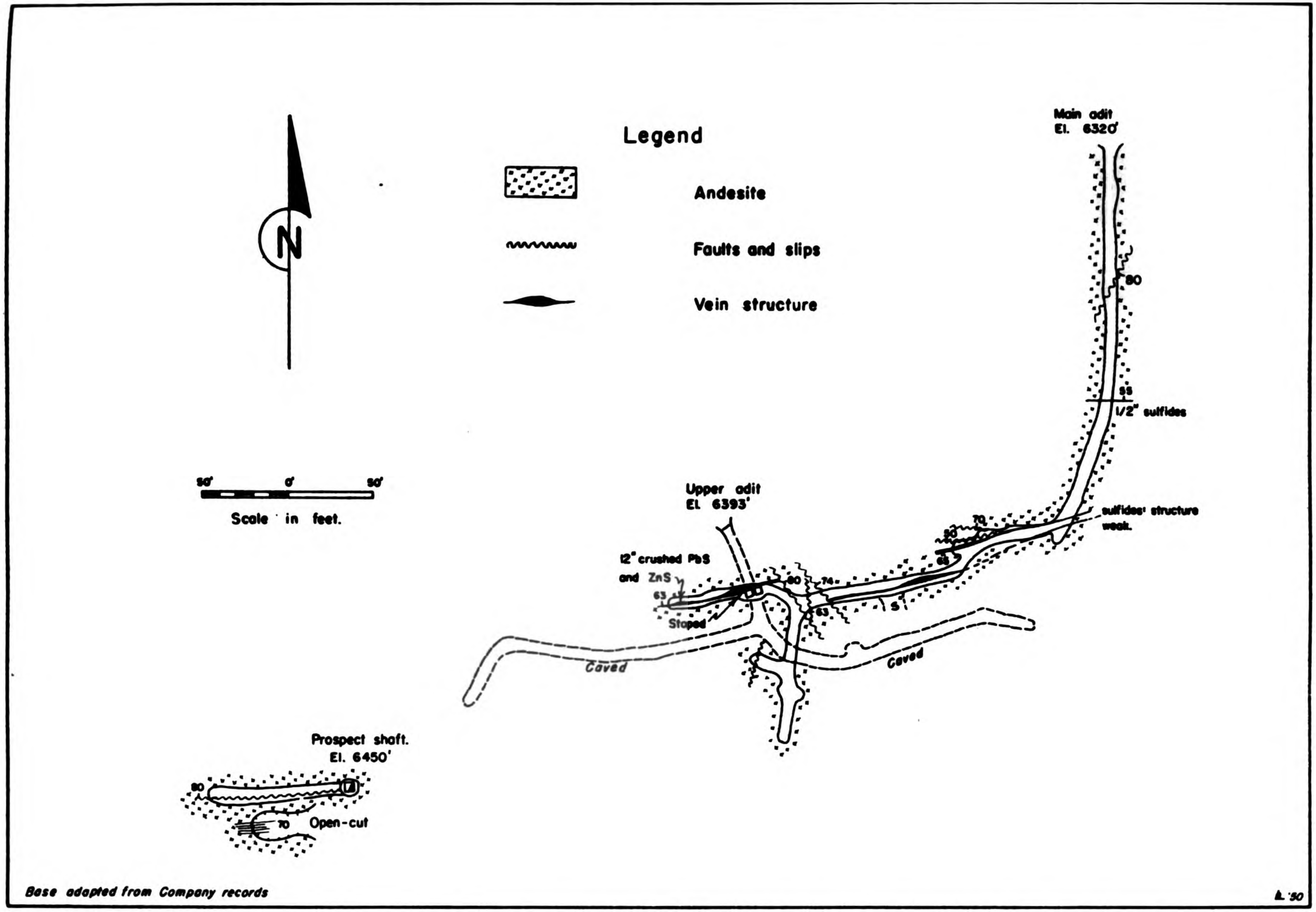


Figure 16. - Geologic plan of the Little Bonanza mine, Winston region, Broadwater County, Mont.

4 feet in width. The enclosing quartz-monzonite is strongly sericitized to 4 feet on each side of the vein structure. On the vein hanging wall, the sericitized zone is succeeded by a 70-foot alteration shell marked by silicification and light pyritization.

The ore is a complex mixture of base metal sulfides and occasional sparse amounts of stephanite in a silicified monzonite gangue. Galena, sphalerite, and tetrahedrite are accompanied by pyrite and quartz. Locally, the sulfides appear to cement and partly replace a monzonite breccia. In places the galena exhibits laminated texture resembling schistosity.

Available records show that the recovered metal content of the Little Olga ores averaged 6.7 percent lead, 18.7 ounces silver, and 0.047 ounce gold a ton. Ores produced in 1948 contained 6.7 percent zinc (5).

Stray Horse (Ag-Pb)

The Stray Horse mine (fig. 11) is on Weasel Creek. According to local reports, production from this property prior to 1901 amounted to more than $200,000. Since 1901 this mine has been operated intermittently on a small scale by a succession of leasing groups. Recorded output from these ventures is less than 500 tons of ore. The mine has been dormant since 1942; the workings now are inaccessible and all equipment has been removed.

Five adits, several shallow shafts, and prospect cuts partly explore two parallel veins in andesite along a horizontal distance of 1,200 feet and over a vertical interval of 460 feet. These veins, spaced about 100 feet apart, strike eastward, dip 80° N., and are less than 2 feet wide. They are offset about 20 feet to the left by a series of north-trending faults. Wall rock alteration and intensity of mineralization are low (6).

The ore is a complex mixture of base metal sulfides associated with pyrite and arsenopyrite in a siliceous gangue. Vein samples cut from surface workings contained 1 to 18 percent lead, 1.4 to 20.9 ounces silver, and 0.11 to 0.34 ounce gold a ton. A group of "sulfide" samples presumably taken from the deeper levels contained 9 percent zinc. According to available production records, the recovered metal content of the Stray Horse ores averaged 10.7 percent lead, 21.1 ounces silver, and 0.37 ounce gold a ton (5).

Other Mining Properties

Information concerning other properties in the Winston region is summarized in table 11. The underground workings at these properties now are largely inaccessible. In most cases authentic production data and details of operation could not be obtained.

TABLE 11. - Information on other mining properties in the Winston region, Broadwater County, Mont.

Property, location, and principal metal	Enclosing rock and structure	Strike and dip	Minerals	Indicated grade	Production	Remarks
Freiburg Sec.26, T.8N., R.1W. (Au, Ag, Pb)	Quartz, monzonite and andesite. Replacement along monzonite-andesite contact.	N 70° E 75° SE	Pyrite, galena, chalcopyrite	-------------	$5,000 in gold ore between 1885-1900	Workings now inaccessible include 2 adits and a shaft extending over a vertical interval of 250 feet. Property unequipped.
Gold Bug Sec. 9, T.8N., R.1W. (Au)	Flow-banded andesite. Narrow fracture filling.	S 80° W South	Pyrite, limonite pyrolusite in quartz gangue	Unknown	$20,000 (local report)	Workings inaccessible; property unequipped.
Homestead Sec.10, T.8N., R.1W. (Au)	Andesite. Replacement along weak intersecting fracture system.	S20-68°W 23° NW - 68° NE	Auriferous pyrite in quartz andesite gangue	0.3 to 0.5 oz. Au	10 tons maximum	Underground workings totaling 600 feet explore veins for 300 feet along strike and over vertical interval of 60 feet. Workings in poor condition.
Maine-Sullivan Sec.14,23, T.8N., R.1W. (Au)	Flat-bedded andesite. Narrow fracture filling.	N 70° E Steep	Sparse pyrite limonite with altered andesite, siderite, and calcite gangue	Unknown Low	Unknown	Prospect only opened by 2 adits (inaccessible) along a horizontal range of 450 feet and over a vertical interval of 120 feet.
Native Silver Sec.16, T.8N., R.1W. (Au, Pb)	Fine-grained andesite. Narrow fracture filling.	N 85° E 80° NW	Pyrite, galena, sphalerite in quartz gangue	Unknown 6% Zn reported	Small	Workings inaccessible.
Orphan Boy Secs. 3,4, T.8N., R.1W. (Au)	Quartz monzonite locally altered. Several persistent converging sheeted zones up to 1,100 feet long.	N 63° E 47° SE	Pyrite, chalcopyrite, some molybdenite	Low	Small amount mined and milled before 1900	Workings inaccessible. Small "stringer" of zinc-lead sulfides found on hanging wall on 135- and 200-foot levels.
Sunshine Secs.22,23, T.8N.,R.1W. (Au, Pb)	Andesite. Filling and replacement along brecciated zone up to 4 feet wide. Several converging structures	E 60°-74° S	Limonite in quartz gangue	0.5 oz. Au 10.5 oz. Ag 4.2% Pb	1,600 tons	Opened by several adits and shallow prospect shafts over a vertical range of 300 feet. Workings inaccessible in 1949. Brecciation possibly controlled by nearby fault striking S. 15° W. and dipping 71° E. Property idle since 1941.
Sunrise Sec.35, T.8N., R.1W. (Au, Ag, Pb)	Quartz monzonite-andesite. Replacement along contact fault.	S 40° E 60° NE	Pyrite, native Au, galena sphalerite and chalcopyrite	Early output reported at $45/ton	$50,000	Property idle for many years. Workings inaccessible.
Vossburg Sec. 3, T.7N., R.1W. Sec. 34, T.8N., R.1W. (Au, Ag)	Quartz monzonite. Replacement and filling along weak fractures.	S 10° E 30° SW	Pyrite, limonite, MnO_2, traces of galena and sphalerite stains in quartz gangue.	0.28 oz. Au, 1.4 oz. Ag, small bunches contain 1 oz. Au or better	24,000 tons	Equipped in 1935 with 50-ton cyanide mill, now dismantled. Camp accomodations for 30 men, in good condition. Plant formerly electrified. Workings largely inaccessible.

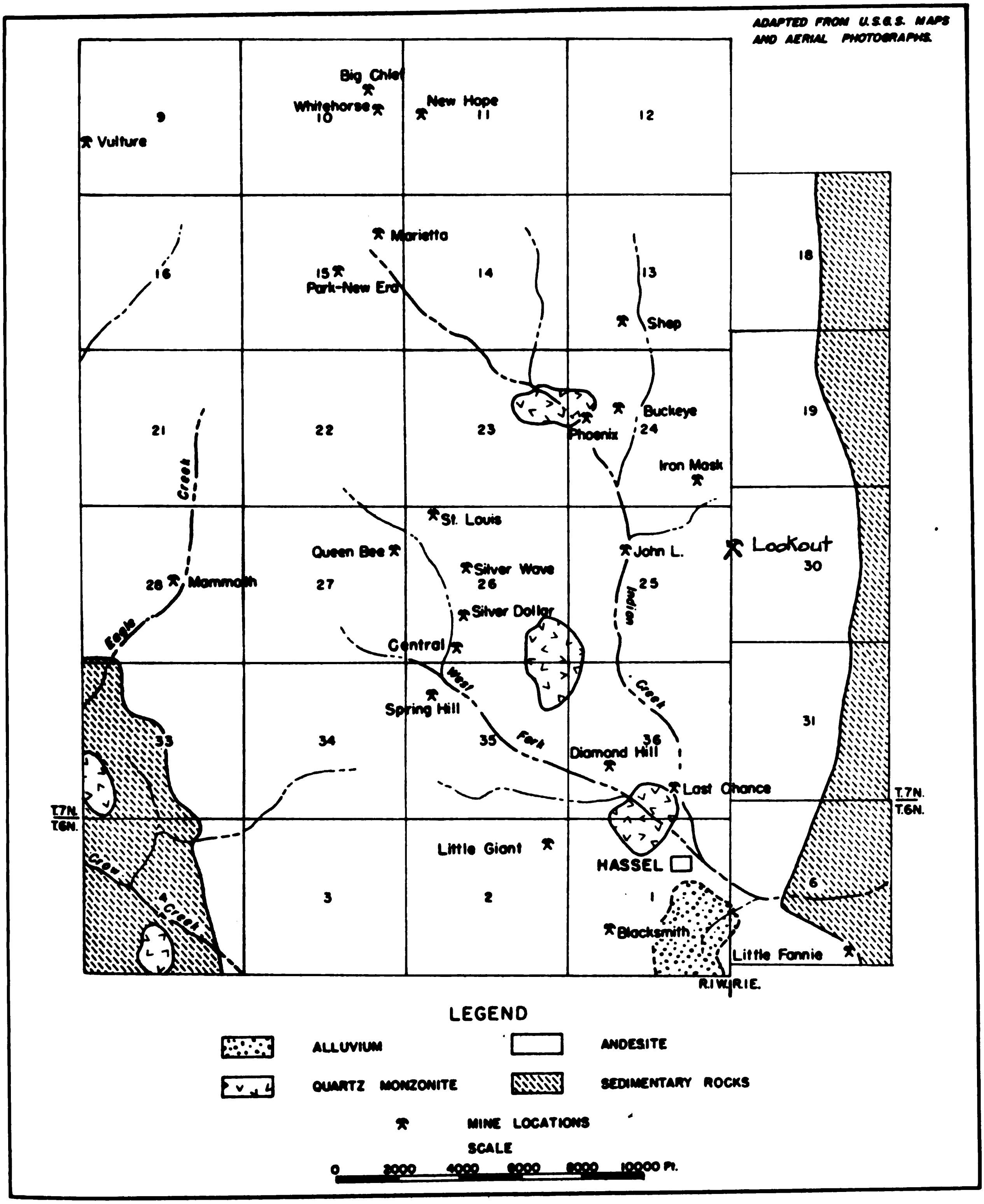


Figure 17. - Geologic map of the Indian Creek region, Broadwater County, Mont.

Indian Creek Region

Location and Access

The Indian Creek mining region includes an area of 24 square miles centered about 9 miles west from Townsend, Mont. It is reached from Townsend and U. S. Highway 10N by graded and maintained county reads along Indian Creek to the old camp of Hassel, where branching roads lead to the interior. A maintained truck road continues from Hassel along Indian Creek to the Marietta mine at the region's northwest extremity and to the Winston mining region via the Mason Park Pass.

Physical Features

The region is on the east slope of the Elkhorn Range and extends from the divide eastward to the benchlands flanking Townsend Valley. It is moderately rugged, with altitudes ranging from 5,000 feet to 8,000 feet or more. Most of the mines, however, are below 6,500 feet in altitude.

Drainage is largely by Indian Creek and its tributary, West Fork, to the southeast into the Missouri River. The western portion of the area joins the Radersburg drainage system through Eagle Creek and Crow Creek. The stream gradients generally are steep; on Indian Creek the average gradient is about 380 feet per mile. In spite of these streams and the numerous small springs, the surface-water supply throughout the area is not abundant. It appears that impounding would be necessary to insure enough water for medium-scale metallurgical applications.

Those parts of the region below 6,000 feet altitude generally are untimbered grazing lands. Above this altitude, however, the forest cover rapidly increases along the protected north slopes. The upper drainage basins of both Eagle Creek and Indian Creek are moderately forested with stands of fir and lodgepole pine. Most of the timber consumed by both early and present-day mining has been logged from these areas.

Geologic Setting

The Indian Creek region is largely underlain by upper Cretaceous andesites intruded by a series of small quartz-monzonite stocks (fig. 17). The stocks are members of an extended intrusive chain described elsewhere in this report. The andesites closely resemble those found throughout the Radersburg and Winston mining regions. Flow banding, however, is not as conspicuous as in the Winston region. The original thickness of the Indian Creek andesites probably was considerably more than 2,000 feet.

The east boundary of the region is marked by a contact between lower Cretaceous shales and the overlying andesites. A rather complete sedimentary sequence continuing eastward to the Missouri River Valley includes formations of the Mesozoic to Proterozoic age. This sequence has been described briefly in the discussion of the Radersburg mining region. The oldest rocks probably belong to the Spokane formation of the Algonkian Belt series.

The sedimentary formations are warped into a broad, north-trending syncline whose east limb is exposed along the lower reaches of Indian Creek. The west limb is almost completely buried by the andesite flows, which comprise the main mass of the Elkhorn Range. A small area of tactites at the Diamond Hill mine on the West Fork probably are sedimentary remnants of this limb.

The andesites, quartz-monzonites, and sedimentary series are dislocated by a number of northwest-trending fauls which can be traced from the terraces along the river valley across the sedimentary rocks and into the andesites for distances of 10 miles or more. It is emphasized that virtually all of the known vein deposits either are near such faults or near areas of quartz monzonite cut by the faults. A few deposits are shear-zone replacements within fault strands.

The Indian Creek fault, extending northwest through Hassel and along the West Fork, is the largest recognized break. The Little Fannie, Blacksmith, Diamond Hill, and Little Giant are some of the productive veins associated with this structure. A horizontal component of movement of about 1,100 feet has displaced the south block eastward with respect to the north block. A similar break south of the Iron Mask mine continues into the Upper Indian Creek Basin, which contains the Sullivan, Marietta, and related veins. Other northwest-trending breaks cut the andesites near the Little Bonanza and Kelly mines in the Winston region.

Lodes in andesite near the quartz-monzonite bodies generally have pronounced alteration halos. Alteration in the vicinity of the Diamond Hill lode, the Blacksmith, and the Little Giant is intense. At the Marietta and Iron Mask mines, wall rock alteration is evident, but only to a relatively smaller degree. Widespread bleaching and pyritization at the Whitehorse prospect suggests the proximity of an unexposed intrusive body.

Ores produced from the Indian Creek lodes are valued chiefly for their gold content. Several veins, however, have produced notable amounts of lead, some silver, zinc, and small quantities of copper. One persistent gold-bearing lode on West Fork contains traces of bismuth and tungsten. According to local reports, the gold content of ores taken from early-day shallow workings averaged better than 1 ounce a ton. A marked decline in gold tenor was experienced generally as development extended to depth.

Blacksmith (Au)

The Blacksmith mine (fig. 17) is credited by local accounts with an output of $250,000. It was exploited chiefly prior to 1880. Recent activity extending from 1932 to 1941 consisted of a sporadic, small-scale leasing operation, which produced a small tonnage of gold ore. In 1949 the workings were inaccessible, and all surface-plant equipment had been removed.

The deposit has been opened by a single adit, a 200-foot vertical shaft, and a series of prospect cuts along a horizontal distance of 2,000 feet. The vein appears to be a replaced shear zone in intensely altered andesite. It strikes N. 3° W. to N. 12° E., dips 85° E., and ranges from 2-1/2 to 4 feet in width. Several stope break-throughs indicate that a second vein or vein split about 20 feet east of the main vein was explored. The alteration persists over a widespread area, which includes parts of the Little Giant, Diamond Hill, and other properties. It apparently has resulted from the intrusion of a small quartz monzonite body north of the Blacksmith workings.

The vein minerals are auriferous pyrite and limonite in a bleached and pyritized andesite gangue. A few fragments of tactite found on the shaft dump were devoid of pyrite. According to production records (5), the recovered metal content of the output since 1901 averaged 1.16 ounces gold, 0.4 ounce silver a ton, and small amounts of copper and lead. Shipments made in 1932 contained more than 4 ounces gold a ton.

Daimond Hill (Au-W)

The Diamond Hill mine (fig. 17) is about 1 mile north west of Hassel at an altitude of 5,500 feet. Its discovery in the late 1870's makes it one of the first lode deposits to be exploited in the Indian Creek region. The property was acquired in the 1880's by a Scottish company and aggressively developed until the early 1900's. Several haulage adits were driven. A 40-stamp and a 120-stamp amalgamating mill were installed and operated. Most of the ore produced was extracted by glory-hole methods. Total production resulting from these operations is placed at $500,000 (4). Since 1940, a small annual output has been maintained by surface "pocket-hunting" ventures. Ores are currently treated on the property by a gasoline-powered, 10-stamp, amalgamating mill. The present operation, conducted by open-cut methods, is equipped with a three-eighths-cubic yard gasoline-powered shovel, a 210-cubic foot compressor, and jackhammers. About 10 tons of ore a day is mined and concentrated.

Development workings include eight adits aggregating 3,600 feet in length, several small open cuts, and one shallow prospect shaft. These openings explore and develop the lode along a horizontal distance of 2,700 feet and over a vertical interval of 250 feet. In 1949, only small parts of these workings were accessible.

The deposit is a replacement and fracture-filling lode in andesite intruded by dikes of aplite and quartz monzonite. It strikes N. 7° W., dips 40° to 85° NE., and ranges from 50 feet to 175 feet or more in width. The average width appears to be about 100 feet. The ore shoots minable under present economic conditions are erratic in size and distribution. They are chimneylike structures ranging from 2 feet to 10 feet or more in diameter. The margins of the ore shoots usually are determined by panning rather than by the recognition of structural changes. However, occasional limiting structures that mark the boundary between an ore shoot and the lower-grade material comprising the bulk of the lode can be discerned. The lode and the enclosing andesites are intensely bleached and pyritized. This halo extends outward beyond the margins of the deposit for several hundred feet.

The ore is a silicified and bleached andesite containing pyrite, limonite, scheelite, and native gold. Tetradymite, a bismuth telluride, is a sporadic accessory mineral occasionally associated with the higher-grade ores. Scheelite, usually associated with pyrite or limonite, apparently is distributed widely throughout the lode. Preliminary sampling at widely separated points indicates that the tungsten content probably is not more than 0.1 percent WO_3. No satisfactory recovery of scheelite has been made by the installed concentrating equipment. The ore is erratic in grade. Small lots extracted during early operations contained 16 ounces of gold a ton. Average metal recovery during a recent operating period ranged between 0.10 and 0.50 ounce gold a ton (5).

Iron Mask (Pb-Zn)

The Iron Mask mine (fig. 17) is about 7 miles west from Townsend, Mont. Information concerning the property's early history and production is not available. It was prospected and intermittently developed during the years 1904-40. Recorded output during this period amounted to about 1,200 tons of ore. In 1943 the mine was rehabilitated, a systematic development program was established, and a 75-ton flotation mill was installed. Extraction at a rate of about 5,000 tons annually was continued until 1947, when the operation was suspended. In 1948, a 65-foot winze from the adit level was unwatered and deepened to 100 feet. Work finally was terminated in early 1949 owing to depressed metal prices.

The principal working is a 2,300-foot crosscut adit which penetrates the Iron Mask vein about 570 feet below the outcrop. The vein has been developed through this opening by a series of raises and stopes along a horizontal distance of 600 feet. In 1948 most of the stopes and the shaft workings on the outcrop were inaccessible. When visited in 1949, the 100-foot winze was flooded to the collar. Most of the mining equipment had been removed. However, the electrified selective flotation plant below the adit portal was reported to be in good condition.

The principal vein structure is a fracture filling and replacement in andesite. It strikes N. 15° W., dips 75° to 85° NE., and ranges from 1-1/2 feet to more than 4 feet in width. At some places the vein is frozen to the enclosing andesites; elsewhere, a thin parting of clay generally marks the vein walls.

The ore shoots within the vein structure are relatively small discontinuous lenses along both the strike and the dip. Generally they are enveloped in a thin shell of sericite. They range from 1 foot to 4-1/2 feet in width and extend along the strike for about 60 feet. The ore is silicified andesite containing galena, sphalerite, pyrite, limonite, and quartz. Chalcopyrite and tetrahedrite are sparingly distributed within some of the ore shoots. According to available records, the recovered metal content of the mined ore averaged 4.0 percent lead, 7.4 percent zinc, 0.2 percent copper, 0.005 ounce gold, and 4.9 ounces silver a ton (5).

A parallel vein structure about 15 feet west of the Iron Mask vein has been exposed by footwall exploration. Development of this structure has been postponed because of its indicated low metal content and extreme oxidation. A third vein penetrated near the adit portal has been explored by drifts for a distance of 350 feet. This structure strikes N. 10° E. to N. 10° W., dips 77° E., and ranges from 1 foot to 5 feet in width. Its general character is indicated by the following sampling data:

	Width, feet	Ounces		Percent			
		Gold	Silver	Lead	Zinc	Copper	Manganese
	1.5	0.04	0.52	Tr.	0.3	0.3	1.5
	2.8	.04	2.72	Tr.	.1	1.3	6.5
Total and average....	4.3	.04	1.95	Tr.	.2	.9	4.7

This vein also is highly oxidized throughout the zone of existing explorations. Beneficiation tests at plant scale indicated that reasonable recoveries cannot be made by standard flotation methods.

Little Fannie (Pb-Zn)

The Little Fannie group occupies a prominent saddle immediately south of Indian Creek and about 1 mile southeast of Hassel (fig. 17). Local accounts indicate a small output of lead-gold ore was derived from prospecting activities on the deposit in 1924. Small-scale prospecting was resumed in 1937 and continued intermittently until 1940. At the present time the mine is dormant and unequipped.

Underground workings with a combined length of about 800 feet consist of a short adit, an inclined shaft, and a shallow vertical shaft; all are interconnected. The adit and vertical shaft were inaccessible in 1949. The incline could be traversed for about 100 feet. These workings explore a weak vein structure in mildly altered andesite over a strike length of 160 feet and a vertical range of 90 feet.

The vein is a fracture filling and replacement structure striking N. 20° E. and dipping 30° NW. As exposed in the inclined shaft, it ranges from 1 to 2 feet in width and is marked by several inches of footwall clay. Ore fragments found on the waste dumps consist of altered and silicified andesite containing pyrite and limonite together with sparse cerussite, galena, and sphalerite.

Little Giant (Au)

The Little Giant mine (fig. 17) is about 1 mile west of Hassel. According to local accounts, production prior to 1901 approached $300,000. Since the turn of the century, the mine has been sporadically prospected by small leasing groups. The recorded output from these later operations has amounted to less than 500 tons of ore.

The underground workings along the lode consist of several drift adits, three shafts, and a low-level crosscut. Most of these workings are inaccessible or in poor repair. In 1949 the property was idle and unequipped.

The Little Giant lode consists of 11 or more parallel, westward-trending, narrow fracture veins in andesite extending over a horizontal distance of 2,700 feet. This lode system is about 1,300 feet wide. The veins are marked by exceptionally regular walls devoid of gouge or other evidence of lateral movement. An aplite dike exposed by the lower workings may be genetically associated with the lode mineralization.

The predominant vein minerals are pyrite and limonite in an intensely altered andesite gangue. Dumps at several development workings near the lode's west extremity contain occasional vein fragments marked by small amounts of galena, chalcopyrite, and pyrolusite. Records of production since 1901 indicate the average recovered metal content to have been 0.84 ounce gold and 0.3 ounce silver a ton (5).

Lookout (Ag-Pb)

The Lookout prospect (fig. 17) is about a half mile southeast of the Iron Mine at an altitude of 6,500 feet in sec. 30, T. 7N., R.1E. Local accounts indicate that the property was discovered and briefly prospected in the 1890's. Although production data are not available, early output is said to have amounted to about 100 tons of rich lead ore. In 1949 a shallow prospect shaft was being rehabilitated, and the character of the vein was determined by sampling. All work was accomplished by hand tools.

The vein is a steep-dipping, narrow fracture filling and replacement in andesite. It strikes N. 20°-30° E., dips 74° SE., and ranges from 1 foot to 16 inches in width. The vein footwall is marked by a 2-inch seam of clay; the hanging wall is frozen. In spite of the vein's narrow width, it apparently persists about 2,700 feet northward to the Iron Mask adit (fig. 17). A small fracture filling vein penetrated near the portal of this adit appears to correspond to the Lookout vein.

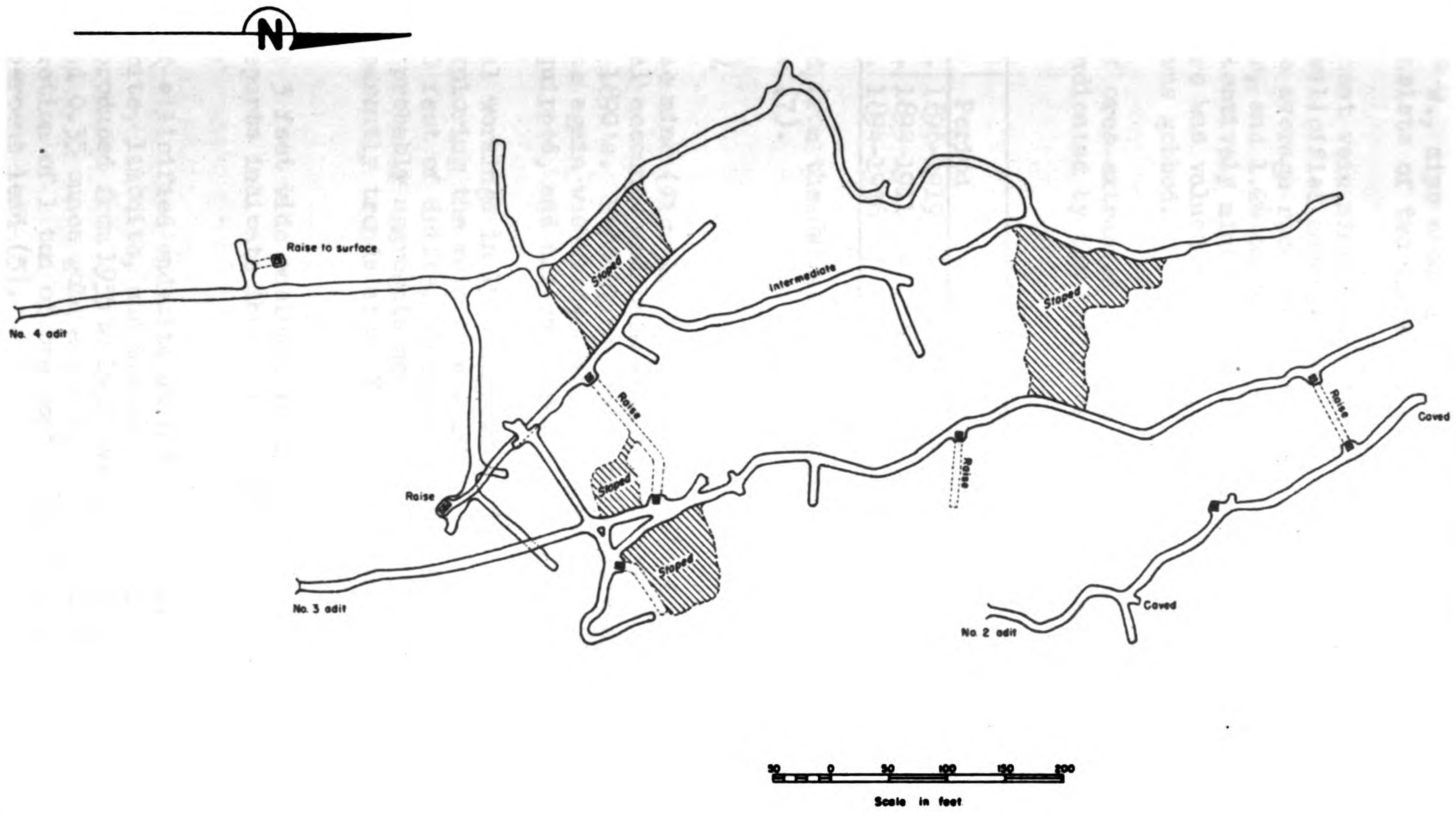
Ore extracted during shaft rehabilitation work contained galena, pyrite, and pyrolusite in a siliceous gangue. A small test shipment of selected ore contained 32 percent lead, 6 ounces silver a ton, and a trace of gold.

Marietta (Au-Ag-Pb)

The Marietta group (figs. 17 and 18) contains 11 patented lode claims in upper Indian Creek Basin at an average altitude of 7,400 feet. According to local accounts, this area was intensively prospected and developed from 1880 to 1906. During this period, several thousand tons of ore valued chiefly for gold was mined from the various lodes. After the consolidation of several individual holdings, a low-level development adit was started and a small cyanide mill built. In 1908 work on this adit was terminated several hundred feet short of its initial objective. The property remained inactive, with the exception of a few scattered ore shipments, until 1933, when the Marietta and Little Annie workings were reopened. Small-scale operation continuing to 1945 resulted in an output of 5,400 tons of gold ore. Operations again were resumed on the Marietta lode in 1949. Present equipment includes a gasoline-driven, 210-cubic foot, portable compressor.

The greater part of the formerly extensive workins at the Marietta, Little Annie, and other mines in the area is inaccessible. Consequently, the character and attitude of the veins could be determined in only a few instances. Most of the veins are tabular bodies trending north to northeast and dipping less than 35° to the west. The Gold Dust vein, however, strikes eastward and dips about 25° S. The Bullion King deposit was described as a shallow, steeply inclined chimney having a plan area of about 25 square feet. Its long axis was reported to have trended northward (7).

All are fracture-filling and replacement structures 6 inches to 3 feet wide enclosed in andesite. The Marietta lode, apparently the most persistent of the group, has been explored and developed by four adits along a horizontal distance of 2,100 feet and over a vertical interval of 300 feet (fig. 18). It



Adapted from Company maps.

Figure 18. - Plan of the Marietta mine workings, Indian Creek region, Broadwater County, Mont.

strikes N. 5°-20° W., dips about 12° SW., and ranges from 8 inches to 3 feet in width. It consists of two right-echeloned units about 130 feet apart.

The predominant vein minerals are pyrite, arsenopyrite, galena, and sparse sphalerite in a silicified andesite gangue. Records of production since 1901 indicate that the average recovered metal content has been 4.8 percent lead, 7.5 ounces silver, and 1.24 ounces gold a ton (5). In 1949 about 10 inches of ore was being selectively mined from a vein 3 feet wide. According to the operator, this ore was valued at $75 a ton. The balance of the vein averaging about $20 a ton was gobbed.

The grade of ores extracted from the Bullion King, Gold Dust, and Little Annie veins is indicated by the following tabulation based on company records:

Vein	Period	Tons produced	Gold, oz./ton	Silver, oz./ton	Lead, percent
Bullion King.....	1896-1919	340	-	12.0	55.0
Gold Dust........	1899-1911	375	1.40	13.0	11.0
Little Annie.....	1894-1936	600	1.28	14.0	7.0

Ore produced from the Switzerland vein is said to be similar in tenor to the Gold Dust ore (7).

Queen Bee (Au-Ag)

The Queen Bee mine (fig. 17) is in the West Fork Basin at an altitude of 6,500 feet. Local accounts indicate that the vein first was prospected and developed in the 1890's. Production during this early period of activity is unknown. The mine again was active during the period 1935-37. In 1949 the property was unequipped, and all underground workings were inaccessible.

The principal workings in 1935 consisted of a 200-foot crosscut adit, a 175-foot shaft exploring the vein to a depth of 100 feet below the adit level, and more than 250 feet of drifts. These workings, together with additions made since 1935, probably aggregate more than 1,000 feet. The vein dips steeply northward and apparently trends about N. 50° W., parallel to the Indian Creek fault.

A vein about 3 feet wide enclosed in andesite is partly exposed at the shaft collar. Reports indicate that this structure occasionally approached a width of 20 feet.

Fragments of silicified andesite at the shaft dump contain fine-grained pyrite, arsenopyrite, limonite, and traces of chalcopyrite. The recovered metal content of ores produced from 1935 to 1938 averaged 0.1 percent copper, 2.6 ounces silver, and 0.35 ounce gold a ton (5). Records for 1942 credit the mine with a production of 1 ton of ore containing 213 ounces gold, 35 ounces silver, and 4.9 percent lead (5).

Silver Wave (Au-Ag-Pb)

The Silver Wave mine (fig. 17) is at the head of West Fork Basin. It was discovered in the 1880's and intermittently developed until 1911. During this period a small tonnage of lead-silver-gold ores was produced. In recent years a small amount of ore has been taken from surface cuts along the vein. A few tons of material sorted from the waste dumps was treated in a small gravity concentrator on Indian Creek in 1949. At the present time, the property is unequipped, and the workings are flooded.

The property is developed by two shafts 100 feet and 350 feet deep and four levels. These workings, together with crosscuts on the 250 and 350 levels, are said to aggregate about 2,100 feet. The horizontal extent of the vein, as indicated by outcrops and shallow prospect cuts, appears to be at least 2,300 feet.

The Silver Wave vein trends N. 50° W. and dips 78° NE.; it is about 3 feet wide. Surface exposures indicate it to be a replacement lode in sheared andesite. According to company records, the structure ranged from 2 feet to 35 feet in width on the lower level.

A steeply dipping vein striking N. 72° E. across the Silver Wave structure is credited with about 40 percent of the mine's total output. It is said that virtually all production from both veins was taken from development headings and hand-sorted at a 9:1 ratio to shipping grade (8).

Ore fragments at the shaft dump contain fine-grained pyrite, occasional crystals of galena, and sparse carbonates in a bleached and silicified andesitic gangue. According to production records, the recovered metal content of the output since 1901 averaged 15 percent lead, 9.1 ounces silver, and 0.76 ounce gold a ton (5). Company records indicate that 800 tons of ore shipped prior to 1901 had a gross value of $28,000.

In 1949, material from the shaft dump was crushed in a gasoline-powered, five-stamp mill and concentrated on a Diester table at a rate of 16 tons per shift. The resulting concentrates contained about 12 percent lead, 12 ounces silver, and 0.5 ounce gold a ton. The ratio of concentration was estimated at 20:1.

Spring Hill (Ag-Pb)

The Spring Hill mine (fig. 17) is in the West Fork Basin at an altitude of 6,100 feet. According to local sources, the mine was opened in the early 1900's and intermittently operated over a period of several years. It has been reopened and briefly prospected several times since 1934. An output of about 200 tons of lead-silver ore is claimed for these recent ventures. In 1949 a part of the workings was being rehabilitated preliminary to an engineering appraisal.

The prospect is developed by a single drift adit containing several raises and branching crosscuts. These workings, aggregating about 800 feet in length, explore the Spring Hill vein along a horizontal distance of 350 feet and within a vertical interval of 50 feet. A second mineralized structure has been penetrated by a short crosscut north from the main workings.

The Spring Hill vein is a narrow fracture filling in andesite. It curves in strike from N. 68° W. to west, dips from 76° S. to 66° N., and ranges from 2 inches to 6 inches in width. This vein is accompanied by 2 feet or more of footwall sheeting and an inch of alteration clay. The predominant vein minerals are pyrite, galena, limonite, sparse sphalerite, and quartz. The ore, valued chiefly for lead and silver, is said to average about $35 a ton.

The structure penetrated by crosscutting is a shear replacement 16 inches wide, striking N. 60° W., and dipping vertically. Apparently, it is a strand of the Indian Creek fault. Its principal constituents are crushed quartz, fine-grained pyrite, and disseminated galena. It is reported to contain about 0.25 ounce gold a ton.

Whitehorse (Ag-Pb)

A brief description of the Whitehorse prospect (fig. 17) is included in this report as it is one of the few prospecting ventures currently in progress in Broadwater County. It is at the head of Whitehorse Gulch at an altitude of 7,100 feet and about 2,000 feet north of the Marietta lode. The prospect is credited locally with a small output of unusually rich lead-silver ores made in the late 1890's.

Several years ago the discovery of massive galena at one of the old adit dumps resulted in an attempt to reopen the workings. As rehabilitation work neared an old stoped area, the opening was irretrievably lost by caving before the character and attitude of the vein could be determined. A new crosscut adit was started 80 feet below the old working. In 1949 the adit had attained a length of 300 feet. The equipment includes a gasoline-driven, 210-cubic foot portable compressor.

The adit is in altered and sheeted andesite containing abundant disseminated pyrite. The sheeting planes strike N. 10° W., dip 70° NE., and usually are stained by manganese oxides. Several small, northwest-trending slips containing clay and enclosed by several inches of silicified andesite have been exposed near the adit heading. Available evidence suggests that the old Whitehorse workings exploited a small lenticular ore body along the northward extension of the Marietta lode. The intensity of alteration and profuse sheeting encountered in the prospect adit apparently support this belief.

Other Mining Properties

Table 12 presents available information concerning other properties in the Indian Creek region. Several mines listed in the table are reported to have been substantial producers prior to 1901. Reliable information regarding output, grade of ore, and former extent of workings, however, is meager. Virtually all of the underground workings at these properties are inaccessible. Consequently, the tabulated descriptions, based mainly on surface observations, are limited in scope.

TABLE 12. - Information on other mining properties in the Indian Creek region, Broadwater County, Mont.

Property, location, and principal metal	Enclosing rock and structure	Strike and dip	Minerals	Indicated grade	Production	Remarks
Big Chief (Gold Mint) Sec.10, T.7N., R.1W. (Au)	Andesite. Fracture filling and replacements.	N 55° E 32° SE	Auriferous pyrite in quartz gangue.	0.7-1.0 oz. Au/ton	Less than 400 tons	Inaccessible workings consist of 2 adits and raises aggregating 1,500 feet. Structure explored along horizontal distance of 350 feet. Vertical range - 250 feet.
Buckeye Sec.24, T.7N., R.1W. (Au, Pb)	Andesite. Replacement along weak shear.	N 55° W 90°	Pyrite, galena, sparse sphalerite, ankerite.	Unknown	Less than 200 tons.	Workings inaccessible. Horizontal range about 150 feet. Vertical interval - 50 feet. At surface exposures, vein ranges from 6 inches - 2-1/2 feet wide.
Central (J.I.C.) Sec.26, T.7N., R.1W. (Ag, Pb)	Quartz monzonite. Fracture filling 2-1/2 feet wide.	S 45° E 87° SW	Fine-grained pyrite, galena, sphalerite.	Unknown	Unknown	Inaccessible workings consist of 2 adits and a shaft. Development extends over horizontal range of 400 feet.
Cooney Sec.26, T.7N., R.1W. (Au, Ag, Pb)	Andesite. Replacement and filling along shear near small body of quartz monzonite	N 50° W 75° NE	Pyrite, limonite	Unknown	Small	Opened by several inaccessible shafts. Structure appears to eastward extension of Silver Wave lode.
John L. Sec.25, T.7N., R.1W. (Au, Ag, Pb)	Andesite. Replacement along shear quartz monzonite contact.	N 40° W Steep	Pyrite, galena, chalcopyrite in quartz gangue.	0.47 oz. Au 7.4 oz. Ag 2.0% Cu 2.3% Pb	Small	Inaccessible; opened by 2 adits aggregating more than 1,500 feet. Shear related to Iron Mask fault.
Last Chance Sec.36, T.7N., R.1W. (Au, Ag)	Quartz monzonite. Replacement and filling along weak shear parallel to Indian Creek fault.	N 53° W 65° SW	Pyrite, chalcopyrite, sparse tetrahedrite in silicified monzonite gangue	Unknown, valued principally for Au-Ag	Small; prospect only	Opened by 1 shaft and 2 adits; lower adit accessible only. Shear zone about 50 feet wide.
Mammoth Sec.28, T.7N., R.1W. (Au, Pb)	Diorite and andesite. Fracture fill and replacement along and near contact.	N 50° W 34° SW	Pyrite, galena, marmatite, chalcopyrite.	----------	Unknown	Inaccessible. Opened by 2 adits and 1 shaft probably aggregating 3,000 feet. Structure developed along south strand Indian Creek fault. Dumps contain pyrolusite and epidote. Explored over distance of 600 feet.
New Hope Sec.11, T.7N., R.1W. (Au, Ag)	Latite, intensely altered. Replacement and fracture fill.	N 25° W 30° NE	Limonite, scant pyrite.	0.04 oz. Au 0.5 oz. Ag 0.3% Zn	None	Prospect only. Sample cut from shallow cut. Structure appears to persist for several hundred feet.
Park-New Era Sec.15, T.7N., R.1W. (Au, Pb)	Andesite. Replacement and fracture fill.	N 45° E 50° SE	Pyrite, galena, arsenopyrite.	0.3 oz. Au 0.6 oz. Ag 0.3% Pb	11,000 tons since 1901	Developed by 4 adits and 1 shaft - inaccessible in 1949. Reported to be stoped continuously for 1,400 feet. Vein said to be about 2-1/2 feet wide
Phoenix Sec.24, T.7N., R.1W. (Pb)	Andesite. Fracture filling (weak)	N 25° W 75° NE	Scant galena and occasional blebs of chalcopyrite.	Unknown probably low	Less than 100 tons	Vein 1 foot - 1-1/2 feet wide explored by shallow shaft and 3 short adits. Indicated horizontal extent of vein about 400 feet.
Shep Sec.13, T.7N., R.1W. (Au)	Andesite. Weak fracture filling.	N 25° W 79°SW	Limonite in quartz gangue.	Reported about $50/ton in gold.	Small less than 100 tons	Prospect shaft being reopened in 1949. Old stopes mined out to widths of 2-1/2 feet.
Silver Dollar Sec.26, T.7N., R.1W. (Ag, Pb)	Quartz monzonite. Fracture filling.	N 45° W Steep	Galena, pyrite, sphalerite, cerussite, & arsenopyrite	Unknown	Small	Inaccessible; formerly opened by shallow shaft and 3 short adits. Indicated horizontal range of development about 450 feet.
St. Louis Sec.26, T.7N., R.1W. (Au, Ag)	Andesite. Not evident.	N 85° W Steep	Coarse pyrite & arsenopyrite in siliceous gangue. Some fine-grained galena.	0.37 oz. Au 1.6 oz. Ag 0.3% Pb	Less than 500 tons	Inaccessible; developed by a 150-foot shaft. Enclosing andesite intensely altered.
Vulture Sec. 9, T. 7 N., R.1W. (Ag, Pb)	Andesite. Fracture filling.	N 50° E 40° NW	Galena, limonite scant chalcopyrite in drusy quartz.	0.23 oz. Au 5.7 oz. Ag 5.5% Pb	Less than 1,000 tons	Inaccessible. Structure reported to be 2 feet wide. Output prior to 1901 said to contain 50% Pb and 75 oz. silver per ton. Granite-andesite contact about 200 feet west from inclined shaft workings.
W.A. Clark Sec. 2, T.6N., R.1W. (Au)	Andesite. Fracture filling.	N 77° W 75° SW	Pyrite, limonite, galena.	$75/ton	379 tons since 1901	Inaccessible; persistent vein 6 inches to 1-1/2 feet wide opened by 3 adits - member of Little Giant system. Chief values in gold, silver, and lead.

Outlying Properties

Other metal properties in Broadwater County are isolated and remote from the recognized mining regions. Descriptions of two of these properties are included in the following section.

Cleo (Ag-Pb)

The Cleo is 2 miles northeast from Toston, Mont., in sec. 13, T. 5 N., R. 2 E. Local accounts indicate that this prospect first was opened and briefly exploited in 1885. In 1943 about 60 tons of lead-copper ore was produced from the old workings. The prospect then remained dormant until 1949, when 13 tons of ore was reclaimed and shipped from waste dumps. The workings now are inaccessible.

Two shallow shafts, several small open cuts, and a series of prospect trenches mark the course of the vein along a horizontal extent of 250 feet and within a vertical range of about 75 feet. The vein is a freacture filling cutting across the east limb of a small overturned fold in Spokane shales. It trends eastward, dips about 77° S., and ranges from 12 inches to 18 inches in width at surface exposure. The vein fracture apparently is related genetically to the nearby Lombard overthrust.

Ore fragments found on the dumps contain fine-grained galena, pyrite, limonite, sparse copper oxides, and vein quartz in lightly sericitized country rock. The shipping ore produced in 1943 is reported to have contained about 15 percent lead, 1 percent copper, and 5 ounces silver a ton.

Pennsylvania (Cu-Ag)

The Pennsylvania claims in secs. 25 and 26, T. 3 N., R. 1 E. are 11 miles north from Three Forks, Mont., by unmaintained county roads. A small output of copper-silver ore is reported to have been made in 1880 from a shallow incline near the east end of the present claim group. In the years intervening to 1918, the claims were explored sporadically. A number of prospect trenches and several shafts, including the 600-foot Pennsylvania shaft, were opened. Records of production during this period are not available.

In 1948 the Pennsylvania shaft was cleaned out and retimbered. Exploration of the 600-level was proceeding intermittently at a small scale during 1949. The principal underground workings are a 600-foot, two-compartment, vertical shaft with three levels aggregating about 1,400 feet in length. These workings are served by a gasoline-powered hoist. Air is supplied by a Schram 210-cubic foot portable compressor.

The several prospect cuts and shafts trace a sporadically mineralized zone in Madison limestone over a distance of 6,100 feet. This zone, trending about N. 60° W., is accompanied by numerous small tongues and sills of diorite and granite. Its eastern limit is a short distance from the Lombard overthrust.

The limestones at the Pennsylvania shaft are marmarized and transformed locally to tactite and garnet. Some of the limestones are lightly stained by

4032

oxidized copper minerals; a few faces contain scattered flecks of bornite. The mineralized zone is intricately fractured; its trend and extent are not evident from the present shaft explorations.

A private examination report prepared in 1918 indicates that material containing 9.3 percent copper, 0.18 ounce gold, and 5.8 ounces silver a ton was penetrated in the main shaft at a depth of 200 feet. Ore containing 3 percent copper was reported to have continued in the shaft from 225 feet to 310 feet. A "5-foot vein" containing 24.6 percent copper is reported to have been cut at the 450 level (9).

Gold Placer Deposits

Placer gold has been recovered from a dozen or more localities in Broadwater County (fig. 19). At least six areas apparently contained gold placers of considerable value. The principal deposits, found in Confederate Gulch and its tributaries, were not extensive but are included among the outstanding placers in Montana because of their unusual richness.

Although all of the county's known gold-placer areas had been exploited by the 1870's, operations have continued intermittently to the present time. A few of the richer deposits in Confederate Gulch have been reworked with modern equipment. Modern methods also have permitted, elsewhere in the county, working of leaner gravels and deposits mantled by deep overburden. Under present conditions, however, most of the known remaining gravels apparently are of marginal value.

The output of placer gold from Broadwater County prior to 1901 is largely conjectural. Pardee (2) has estimated output from the Belt Mountains region on the basis of local accounts, available reports, and by measurements of the area of worked gravels. Winchell (3) mentions the Radersburg placers, and Lyden (10) has estimated production from Beaver Creek. Table 13 summarizes the minimum estimated output from these placers, their type, and the probable source of the contained gold.

TABLE 13. - Estimated output and character of Broadwater County's principal gold placers

Deposit	Estimated output, dollars	Type of deposit	Source of gold
Avalanche Gulch....	$ 100,000	Bench	Quartz veins associated with diorite dikes.
Beaver Creek.......	200,000	Creek	Quartz veins in andesite.
Confederate area:			
Boulder Bar...	100,000	Bench	Quartz veins in quartz-diorite.
Cement Gulch..	800,000	Creek	Do.
Confed. Gulch.	2,500,000	do.	Do.
Diamond Bar...	1,000,000	Bench	Do.
Montana Bar...	1,000,000	do.	Do.
Montana Gulch.	600,000	Creek	Do.
Crow Creek.........	500,000	do.	Quartz veins in adnesite.
Indian Creek.......	1,500,000	do.	Do.
White Gulch........	1,000,000	Bench	Quartz veins in quartz-diorite.

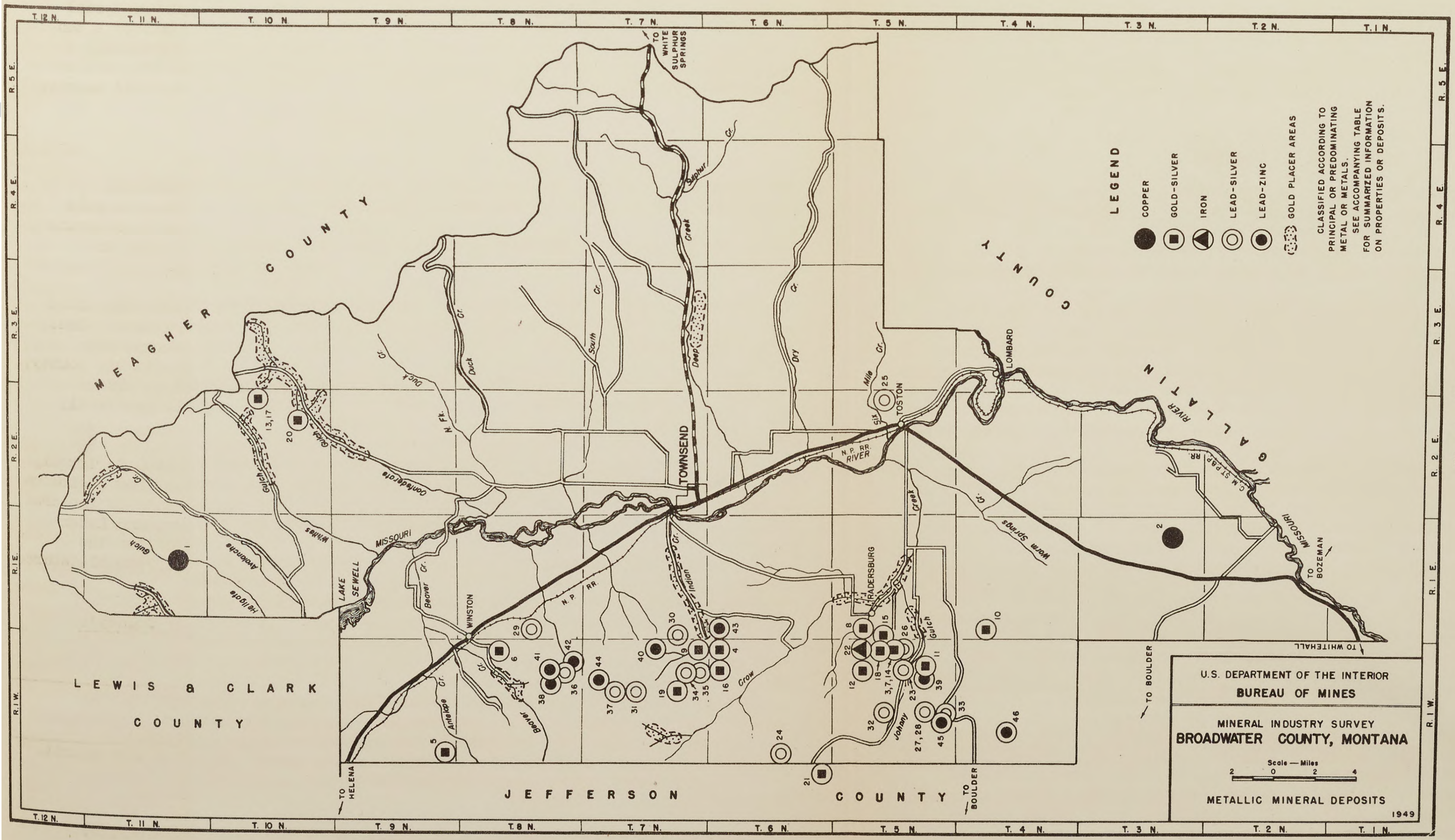

T. 12 N.
T. 11 N.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
R. 5 E.
R. 4 E.
R. 3 E.
R. 2 E.
R. 1 E.
R. 1 W.
MEAGHER COUNTY
GALLATIN COUNTY
LEWIS & CLARK COUNTY
JEFFERSON COUNTY
TO WHITE SULPHUR SPRINGS
TO HELENA
TO BOULDER
TO BOZEMAN
TO WHITEHALL
TOWNSEND
TOSTON
LOMBARD
RADERSBURG
WINSTON
LAKE SEWELL
MISSOURI
RIVER
N. P. RR.
C. M. ST. P. & P. RR.
Deep Creek
Sulphur Cr.
Duck Cr.
South Cr.
Dry Cr.
Six Mile Cr.
N. Fk.
Confederate Gulch
White Gulch
Avalanche Gulch
Hellgate Gulch
Beaver Cr.
Antelope Cr.
Indian Cr.
Crow Cr.
Johnny Gulch
Crow Creek
Warm Springs Cr.
LEGEND
● COPPER
▣ GOLD-SILVER
◬ IRON
◎ LEAD-SILVER
⊙ LEAD-ZINC
GOLD PLACER AREAS
CLASSIFIED ACCORDING TO PRINCIPAL OR PREDOMINATING METAL OR METALS.
SEE ACCOMPANYING TABLE FOR SUMMARIZED INFORMATION ON PROPERTIES OR DEPOSITS.
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
MINERAL INDUSTRY SURVEY
BROADWATER COUNTY, MONTANA
Scale — Miles
2 0 2 4
METALLIC MINERAL DEPOSITS
1949
1
2
5
6
8
10
11
12
13,17
15
16
18
19
20
21
22
23
24
25
26
27,28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
3,7,14
4
9

Figure 19.

A few of Broadwater County's placer areas were intermittently active during 1949. Placer ground along Crow Creek and Keating Gulch in the Radersburg region was under test in 1948 and 1949. At Indian Creek, hyraulic mining along the margin of an earlier cut was attempted for a brief period. In the Confederate area, a short test run was made by dragline on Boulder Bar. Several small-scale hand operations were attempted at Montana and Blacktail Gulches. The salient features of operations on Boulder Bar and Indian Creek in 1949 are described in the following sections.

Boulder

Tje Boulder placer, sec. 35, T. 10 N., R. 2 E., is on the southeast flank of Confederate Gulch near the confluence of Boulder and Confederate Creeks. Although several channels along this bar have been worked in preceding years, its systematic exploitation apparently has been retarded by heavy ground and comparatively low gold content.

In 1949 water was brought to the bar by a three-fourths mile, 10-inch siphon. About 20 feet of bench gravels was stripped by bulldozer and a Diesel-powered 1-1/2-cubic yard dragline from a 4-foot pay streak. This pay streak, together with 18 inches of bedrock, was mined and fed by dragline to a tractor-mounted screening-amalgamating plant. Tailing disposal was accomplished by bulldozer.

Bedrock is a steeply inclined, thinly laminated shale member of the Newland formation. According to the operator, about 50 percent of the recovered gold was estimated at plus 10-mesh in size. It was said to be of 850 fineness. A sample of black-sand rejects from the final cleanup contained 0.94 ounce gold a ton and traces of monazite and zircon.

Indian Creek

The Indian Creek gravels were exploited in 1870 and reworked by dragline during the period 1940-47. These operations apparently made an incomplete recovery of gold from bedrock and along the channel margins. Consequently, cleanup operations were conducted in 1949 in secs. 5 and 6, T. 6 N., R. 1 E.

Old tailings were removed from bedrock, and 15 feet of overburden was stripped from the channel margins by bulldozer. The steeply inclined shale bedrock was cleaned, and a 2-1/2-foot pay streak was hydraulicked into carpeted sluice boxes. Water from a sump pool was supplied to the nozzle at 120 pounds by a 1,000-g.p.m. 6 x 5 centrifugal pump powered by a 4-cycle Diesel engine.

About 30 percent of the recovered gold appeared to be plus 10-mesh in size. A sample taken from the black-sand rejects contained 0.86 ounce gold a ton, traces of zircon, and an appreciable amount of scheelite.

NON METALLIC MINERAL DEPOSITS

The prospecting, development, and exploitation of nonmetallic mineral deposits in Broadwater County have been retarded principally by the absence of local markets and the generally high freight charges to existing outlets. Further, the opportunities presented by the nonmetallics have not been widely appreciated throughout regions dominated for years by the exploitation of metallic minerals.

Several nonmetallic mineral deposits have been observed in Broadwater County. Although of limited economic interest at the present time, they are described briefly in the following pages.

Diatomaceous Earth

Two occurrences of diatomaceous earth in Broadwater County have been recognized by Pardee. They have been described in a U. S. Geological Survey paper (1) from which the following extracts are quoted.

> One deposit was found a mile north of Beaver Creek in sec. 27, T. 9 N., R. 1 E. along a bluff facing the Missouri River. It consisted of two beds each about 1 foot thick. One of the beds is chalk-white, light in weight, and apparently free of foreign matter. The second bed is pale brown and contains a small amount of impurities.
>
> A second deposit was observed north of Greyson Creek in sec. 13, T. 6 N., R. 2 E. The bed is 10 feet thick, thinly laminated, and mixed with a little lime and other substances.
>
> Both deposits, apparently accumulated at the bottom of a pond, are interbedded with Oligocene clay and tuff.

Fluorite

The Normandy (Twin County) fluorite prospect, sec. 24, T. 9 N., R 3 E., is near the Broadwater-Meagher County boundary at an altitude of 8,000 feet. It is undeveloped and opened only by shallow discovery cuts.

A fracture filling and replacement vein in Belt limestones has been exposed by two prospect cuts about 50 feet apart. This vein strikes northwestward, dips about 80° SW., and ranges in width from 13 inches to 6 feet. At one exposure the vein consists of 6 inches of impure fluorite and an equal width of shattered limestone veined with thin stringers of fluorite and quartz. About 5-1/2 feet of limonite and quartz lightly streaked with fluorite are exposed on the vein footwall at the second cut. The hanging-wall unit consists of 0.9 foot of impure fluorite. Samples cut from this exposure assayed as follows:

Width, feet	CaF_2, percent	SiO_2, percent	$CaCO_3$, percent	R_2O_3, percent
0.9	35.2	51.5	0.6	6.2
5.6	1.8	54.6	.4	18.3

Ornamental Stone

A small limestone quarry has been opened by the Vermont Marble Co. in sec. 4, T. 5 N., R. 1 E., about 4 miles north by road from Radersburg.

According to local accounts, the character and extent of the limestone beds were determined by core drilling in 1930. Several carloads of stone was quarried and shipped to eastern centers for sawing and polishing. In 1937 the operation was terminated because of adverse commodity freight rates to eastern markets.

The beds developed by the quarry are in the Lower Cambrian Meagher formation on the east limb of a north-trending anticline. They strike N. 12°W., dip steeply SW., and continue northward without interruption to Indian Creek. The limestone is massive, fine-grained, and colored dark gray. Polished specimens exhibited locally were black and pleasingly streaked with buff to tawny brown markings.

Rock Phosphate

Rock phosphate from the Permian Phosphoria formation has been recognized at several localities within Broadwater County. These deposits have not been exploited owing to their small size and low grade. The known exposures are generally a little more than a foot thick. They consist principally of tiny bone fragments, clay, and shales cemented by dark carbonaceous material. The oolitic texture that characterizes the higher-grade rock phosphates in the nearby Ellison, Garrison, and Maxville fields usually is lacking.

The phosphatic beds are underlain by the conspicuous reef-forming Quadrant quartzite. Consequently, they may be traced easily for considerable distances in the Radersburg and Indian Creek regions.

Rock phosphate in Broadwater County apparently was first observed by Stone (4), who reported float from Slim Sam Creek containing 27 percent P_2O_5. Pardee (2) reported the occurrence of a thin bed of rock phosphate at the mouth of White Gulch in sec. 19, T. 10 N., R. 2 E. Klepper (11) has reported a thin bed of oolitic rock phosphate in Johnny Gulch, sec. 21, T. 5 N., R. 1 W. A character sample from this bed contained 25 percent P_2O_5. Impure phosphate float estimated to contain less than 15 percent P_2O_5 was found by the writer along Indian Creek in sec. 5, T. 6 N., R. 1 E.

REFERENCES

1. Pardee, J. T., Geology and Ground Water Resources of Townsend Valley, Mont.: U. S. Geol. Survey Water Supply Paper 539, 1925.

2. Pardee, J. T., and Schrader, T. C., Metalliferous Deposits of the Greater Helena Mining Region, Mont.: U. S. Geol. Survey Bull. 842, 1933.

3. Winchell, A. N., Mining Districts of the Dillon Quadrangle and Adjacent Areas: U. S. Geol. Survey Bull. 579, 1914.

4. Stone, R. W., Geologic Relations of Ore Deposits in the Elkhorn Mountains, Mont.: U. S. Geol. Survey Bull. 470, 1911.

5. Needham, C. E., Economics and Statistics Service, Bureau of Mines, Salt Lake City, Utah, 1949.

6. Hart, L. H., Report to the Anaconda Copper Mining Co., 1933.

7. Dance, A. J., Personal communication, 1949.

8. Pitts, G. E., Geological Report on the Silver Wave Mine, Broadwater County, Mont.: Undated company records.

9. Ryan, J. D., Report on the Pennsylvania Mine, 1918: Company records.

10. Lyden, C. J., Gold Placers of Montana: Montana Bur. Mines and Geology, Men. 26, 1948.

11. Klepper, M. R., Geologist, U. S. Geol. Survey, personal communication.

MINERAL INDUSTRY SURVEY TABLE
BROADWATER COUNTY, MONT.,1949
Metallic Mineral Deposits 1/

Map ref. no.	Name of property or deposit 2/	Location			Description of deposit	Indicated metal content	Reported production	Remarks
		Sec.	Twp.	R.				
					● - Copper			
1	Argo (Eclipse-Argo)	27	11N	1E	Fracture filling and replacement structure in thin-bedded Spokane argillites; width - 4 to 5 feet. Ore bodies ranged from 6 inches to 2 feet wide.	6.5 percent Cu	31,700 tons ore.	Inaccessible; exploited during period 1902-26. Development by adit, winzes, and intermediates. Formerly equipped with electrified 50-ton concentrator.
2	Pennsylvania	25,26	3N	1E	Zone associated with diorite sills in marmarized Madison limestone locally garnetized and altered in tactites. Oxidized copper minerals and sparse copper sulfides sporadically concentrated along complex fracture system.	"Ore shoots" said to range from 3 percent to 24 percent Cu	None	Developed by 600-foot vertical shaft and 3 levels. Equipped with gasoline-powered hoist and 210-cubic foot compressor
					⊡ - Gold-Silver			
3	Black Friday	13,24	5N	1W	Persistent, steep-dipping fracture filling and replacement vein in andesite. Structure, 5 feet wide, contains occasional lenses of auriferous pyrite. Several intersecting veins.	Recovered: 1.7 oz. Au and 1.0 oz. Ag/ton	7,900 tons since 1901.	Inaccessible; developed by a 2-compartment, 700-foot, timbered incline and 7 additional shallow shafts. Workings flooded.
4	Blacksmith	1	6N	1W	Replaced shear zone in intensely altered andesite near small monzonite plug. Auriferous pyrite and limonite are contained in a bleached and pyritized andesite gangue.	1.2 oz. Au,0.4 oz. Ag/ton. Traces copper and lead	$250,000 prior to 1901.	Inaccessible; developed by a single adit and a 200-foot vertical shaft.
5	Buzz	31	9N	1W	Narrow sheeted zone in andesite containing stringer vein. Small, non-persistent quartz lenses contain auriferous pyrite and limonite.	Reported to range from $20 to $400 gold per ton	About $60,000 since 1891.	Inaccessible; development aggregating 3,000 feet is by 5 adits and 2 shafts. Main adit being reopened in 1949.
6	Custer-Iron Age-Hyantha	13,24	8N	1W	Numerous flat-dipping fracture filling veins in andesite adjacent to quartz-monzonite stock. Additional veins occupy bedding slips in andesite.	Sporadic output since 1901 ranges from 0.2-1.0 oz. Au and 1.0 oz. Ag/ton	$700,000 to $1,500,000 between 1879 and 1901.	Largely inaccessible; group developed by inclined and vertical shafts and several adits. Workings probably aggregate 6 miles or more in length.
7	Cyclone (Simpson)	24	5N	1W	Southward extension of Black Friday structure. Vein about 3-1/2 feet wide contains auriferous pyrite, occasional copper oxides, sparse pyrolusite, galena and sphalerite in siliceous gangue.	Recovered: 0.58 oz. Au, 0.76 oz. Ag/ton	Since 1901 - 399 tons.	Inaccessible; developed by short adit and 2 shallow shafts over vertical range of 200 feet.
8	Delome	7	5N	1E	Replacement and fracture filling along andesite-conglomerate contact. Principal minerals are limonite, pyrolusite, and gold. Gangue marked by epidote.	---------------	Unknown	Inaccessible; explored to a depth of 65 feet by a 2-compartment inclined shaft.
9	Diamond Hill	36	7N	1W	Replacement and fracture filling in andesite intruded by quartz monzonite and aplites. Pyrite, free gold, scheelite with minor hubnerite and tellurides. Lode persists about 2,700 feet along strike and ranges from 50 to 175 feet wide.	Estimated: $5 to $8 gold per ton. Small amount of tungsten, possibly 0.1% or less.	Prior to 1907, $500,000.	Early development workings aggregating 3,600 feet in poor condition. Currently operated at small scale by open-cut methods.
10	Gold Butte	7	4N	1E	Several narrow, sub-parralel fracture veins in hornblende granite. Principal minerals are auriferous pyrite, limonite, and sparse copper oxides.	$15/ton in gold.	About 30 tons.	Inaccessible; developed by 150-foot prospect shaft.
11	Gold Cross (Iowa, Keystone)	26	5N	1W	Two sub-parallel fracture filling veins in andesite about 3 feet wide. Siliceous vein material on dumps contained auriferous pyrite and limonite.	Unknown; apparently intermediate gold content.	Unknown; probably less than 1,000 tons.	Inaccessible; development by shallow shafts and adits along horizontal range of 900 feet and over vertical interval of 150 feet.
12	Hard Cash	11	5N	1W	Steep-dipping fracture vein about 3 feet wide in highly altered andesite. Ore principally auriferous pyrite, limonite with sparse copper and zinc sulfides in siliceous gangue.	Recovered from ore produced since 1901: 1.02 oz. Au, and 0.46 oz. Ag/ton	Unknown tonnage of rich gold ores extracted between 1880-1900.	Inaccessible; developed by shallow shaft and 3 adits possibly aggregating 5,000 feet. One ore shoot developed over length of 250 feet.

MINERAL INDUSTRY SURVEY TABLE
BROADWATER COUNTY, MONT.,1949
Metallic Mineral Deposits 1/ (Contd.)

Map ref. no.	Name of property or deposit 2/	Location			Description of deposit	Indicated metal content	Reported production	Remarks
		Sec.	Twp.	R.				
					⊡ - Gold-Silver (Contd.)			
13	Humming Bird	13	10N	2E	Fracture filling and bedding replacement in Newland shales near quartz-diorite stock. Auriferous pyrite, limonite, and sparse chalcopyrite in drusy quartz gangue.	Recovered: 1.25 oz. Au and 1.7 oz. Ag/ton	43 tons ore since 1901.	Inaccessible; developed by 2 short adits and several prospect cuts along a horizontal range of 400 feet
14	Iron Age	24	5N	1W	Curving fracture vein in highly altered andesite. Ranges from 3-1/2 feet to 5 feet wide at surface. Ore is auriferous pyrite, limonite, and quartz in an andesitic gangue.	Unknown; principally valued for gold.	Unknown; apparently not more than 500 tons.	Inaccessible; idle for many years. Developed by 2 shallow inclines and several prospect pits over distance of 1,600 feet.
15	Keating	18	5N	1E	Persistent fracture filling and replacement 1-1/2 to 5 feet wide in altered andesite porphyry. Ore consists of auriferous pyrite and occasional copper sulfides in andesitic gangue.	Recovered: 0.38 oz. Au/ton. Range: 0.15 oz. to more than 1.0 oz. Au/ton	Since 1901: 412,500 tons.	Inaccessible; last operated in 1947. Developed by 2 shafts and 10 levels over vertical interval of 1,100 feet and horizontal range of 2,200 feet.
16	Little Giant	2	6N	1W	Eleven or more parallel steep-dipping veins in andesite comprise a lode system 1,300 feet wide and extending 2,700 feet along strike. Vein widths range from 2 inches to 6 inches. Predominant minerals are auriferous pyrite and limonite in altered andesite gangue.	Recovered since 1901: 0.84 oz. Au, 0.3 oz. Ag per ton	Output prior to 1901 said to have approached $300,000.	Largely inaccessible; lode developed by several adits, 3 shafts, and a low-level crosscut.
17	Miller (Slim Jim)	13	10N	2E	Narrow zone of irregular quartz veinlets along contact between quartz-diorite stock and Newland shales. Erratic mineralization includes native gold, pyrite, and base metal sulfides.	Recovered: 7.95 oz. Au, 4.6 oz. Ag/ton	1,146 tons.	Developed by 3 adits aggregating several thousand feet. Ore concentrated in gasoline-driven, single stamp-amalgamating mill.
18	Ohio-Keating	13	5N	1W	Persistent fracture filling vein in altered andesite; horizontal extent about 1,600 feet. Vein minerals are auriferous pyrite, limonite, and quartz.	Recovered: 0.31 oz. Au/ton	190,000 tons.	Inaccessible; developed by 600-foot shaft with 5 levels. Operation formerly included 100-ton mill plant. Electrified.
19	Queen Bee	27	7N	1W	Replacement vein along shear zone in andesite ranging from 3 feet to 20 feet wide. Vein minerals are auriferous pyrite, arsenopyrite, limonite, and sparse chalcopyrite.	Recovered during 1935-38: 0.35 oz. Au, 2.6 oz. Ag/ton	Since 1901, 800 tons.	Inaccessible; principally active prior to 1900. Developed by 200-foot crosscut adit and 175-foot shaft.
20	Satellite (Baker group)	26	10N	2E	Quartz lode 3 to 8 feet wide in Newland shale near quartz-diorite stock. Principal vein minerals are pyrite, limonite, and sparse galena in milky quartz gangue.	Recovered: 0.55 oz. Au, 1.0 oz. Ag, and 0.9% Pb/ton	Recorded since 1901: 1,291 tons.	Principally active prior to 1900. Prospect adit being reopened in 1949. Formerly developed by several adits and inclines, inaccessible in 1949.
21	Spar	36	6N	2W	Bedding replacement in Jefferson limestone. Pipe-shaped ore shoot 30 to 60 feet long and 1 to 3-1/2 feet wide. Vein minerals are tetrahedrite, argentite, cerargyrite, and pyrolusite.	1.2% Zn, 0.04 oz. Au, 22.6 oz. Ag/ton recovered	1,000 tons.	Active in 1949. Developed by flat-dipping incline enlarged by stoping. Currently powered by gasoline-driven equipment.
					▲ - Iron			
22	Iron Cross	12	5N	1W	Magnetite with ilmenite 7 to 15 feet thick. In Cretaceous sandstone.	43% Fe, 9.3% TiO_2	4,000 tons.	Small open-cut operation active in 1949. Material used at Trident, Mont., in compounding type V cement.
					◎ - Silver-Lead			
23	Bluebird	23	5N	1W	Steep-dipping fracture vein in altered andesite. Principal minerals are galena, sparse sphalerite, and auriferous pyrite in a siliceous gangue.	----------------	Unknown - probably small.	Inaccessible; developed by 2 shallow shafts to an estimated depth of 100 feet.
24	Bonanza	19	6N	1W	Steep fracture filling and replacement structure in Madison limestone. Ore fragments on dumps contain galena, cerussite, limonite, and pyrolusite accompanied by barite, calcite, and quartz.	----------------	Unknown.	Inaccessible; developed by 10 or more adits extending over a vertical interval of 200 feet and along a horizontal distance of about 600 feet.

MINERAL INDUSTRY SURVEY TABLE
BROADWATER COUNTY, MONT.,1949
Metallic Mineral Deposits 1/ (Contd.)

Map ref. no.	Name of property or deposit 2/	Location Sec.	Twp.	R.	Description of deposit	Indicated metal content	Reported production	Remarks
					◎ - Silver-Lead (Contd.)			
25	Cleo	13	5N	2E	Narrow fracture filling in Spokane shales. Ore contains galena, pyrite, limonite, and sparse copper oxides.	15% Pb, 1% Cu, 5.0 oz. Ag/ton	Small.	Inaccessible; developed by 2 shallow shafts and several open-cuts. Active in 1943 - small scale.
26	Gopher	24	5N	1W	Narrow fracture filling and replacement vein in bleached andesite. Ore consists of galena, cerussite, smithsonite, and pyrite.	8.7% Pb, 1.6% Zn, 9.7 oz. Ag 0.38 oz. Au/ton	Small.	Inaccessible; vein developed by 7 prospect shafts over horizontal range of 1,000 feet.
27	Jo Dandy	28	5N	1W	Fracture filling and bedding replacement in Quadrant quartzite. Hematite gangue contains cerussite, wulfenite, and galena.	34% Pb, 11.9 oz. Ag/ton	9,300 tons.	Inaccessible - workings flooded; developed to depth of 600 feet by shaft with 6 levels. Last operated in 1929
28	Jo Jo	28	5N	1W	Small, steeply plunging ore shoots enclosed in Quadrant quartzite. Ore consists principally of cerussite and galena in a siliceous gangue.	Evidently similar in tenor to the Jo Dandy ore	Unknown - probably less than 500 tons.	Developed by 1 adit and a connecting incline; workings aggregate about 2,000 feet. Several small ore shoots extracted since 1927. Property idle and unequipped.
29	Kelly	19	8N	1E	Series of small fracture filling and replacement veins in andesite. Ore minerals include pyrite, galena, cerussite, limonite, and scant sphalerite.	Test shipment in 1949 - 5.8% Pb, 3.0 oz. Ag, 0.25 oz. Au/ton	Unknown - less than 500 tons.	Explored by several shallow shafts and 3 adits. Workings inaccessible with exception of lower adit workings which aggregate about 1,300 feet.
30	Lookout	30	7N	1E	Steep-dipping, narrow fracture filling in andesite. Ore minerals include pyrite, galena, and pyrolusite.	Test shipment: 32% Pb, 6 oz. Ag/ton	100 tons.	Prospect; being reopened in 1949. Indicated strike length of vein may be 2,700 feet.
31	Marietta	10,15	7N	1W	Fracture filling and replacement veins in andesite. Widths range from 6 inches to 3 feet. Principal ore minerals are pyrite, arsenopyrite, galena, and sparse sphalerite.	Recovered since 1901: 4.8% Pb, 7.5 oz. Ag, and 1.24 oz. Au/ton	About 8,000 tons since 1894.	Veins developed by several adits and inclines largely inaccessible. Marietta adit being rehabilitated in 1949. Formerly equipped with small cyanide plant.
32	North Home	16	5N	1W	Fracture filling and replacement vein in Madison limestone. Ore contains galena, smithsonite, limonite, and sparse manganese oxides. Gangue includes barite, calcite, and siderite.	2.3% Pb, 0.06 oz. Au, 17.4 oz. Ag per ton	3,800 tons since 1901.	Inaccessible. Developed to depth of 300 feet by shaft. Ore reclaimed from dumps in 1947 and 1948.
33	Santa Anita	33	5N	1W	Narrow fracture filling vein in Quadrant quartzite. Principal ore minerals include limonite, cerussite, smithsonite, and pyrolusite. Sparse galena and sphalerite.	23% Pb, 5.7 oz. Ag/ton	1,600 tons.	Developed by adit. Small-scale operation active in 1949. A small amount of zinc has been recovered from ores shipped since 1946.
34	Silver Wave	26	7N	1W	Steep-dipping fracture vein and replacement lode in sheared andesite. Ore consists of auriferous pyrite, galena, and carbonates in a bleached andesitic gangue.	15% Pb, 9.1 oz. Ag, 0.76 oz. Au/ton	1,400 tons.	Inaccessible; developed by 2 shafts, 100 and 350 feet deep. Horizontal extent of principal structure appears to be about 2,300 feet. Output claimed to be from development only.
35	Spring Hill	35	7N	1W	Narrow fracture filling vein in andesite. Second structure exposed apparently is a replacement along narrow shear zone.	$35/ton	Estimated - 250 tons.	Developed by adit workings aggregating 800 feet. Workings being rehabilitated in 1949.
36	Stray Horse	35	8N	1W	Two steep-dipping, parallel veins in andesite. Cross-faulting observed. Ore is a mixture of base metal sulfides with pyrite and arsenopyrite in a siliceous gangue.	10.7% Pb, 21.1 oz. Ag, and 0.37 oz. Au/ton	500 tons since 1901. $200,000 prior to 1901.	Inaccessible; veins developed by 5 adits and several prospect shafts.

MINERAL INDUSTRY SURVEY TABLE
BROADWATER COUNTY, MONT.,1949
Metallic Mineral Deposits 1/ (Contd.)

Map ref. no.	Name of property or deposit 2/	Location Sec.	Twp.	R.	Description of deposit	Indicated metal content	Reported production	Remarks
					◎ - Silver-Lead (Contd.)			
37	Whitehorse	10	7N	1W	Prospect adit being driven to intersect assumed downward extension of small ore shoot exploited by inaccessible early day workings. Structure probably north extension of Marietta vein system.	Galena and pyrolusite remain on dumps from early operation	Unknown.	Adit had attained a length of 300 feet in October 1949. Equipment includes two 210-foot, portable, gasoline-driven compressors.
					◉ - Lead-Zinc			
38	East Pacific	26,27	8N	1W	Persistent fracture filling vein in andesite. Ore commonly shows banded texture. Principal gangue minerals are quartz, calcite, and rhodochrosite. Occasionally contains native gold and tetrahedrite.	6.3% Pb, 2.2% Zn 10.2 oz. Ag, and 0.29 oz. Au/ton	Over $2,000,000. Output since 1901 - 36,000 tons.	Developed by several shafts and 5 adits aggregating 5 miles. Mining suspended in 1947; present operation confined to the milling of waste dumps. Operation electrified and equipped for 100-ton daily mine-mill output.
39	Highland Mary	26	5N	1W	Replacement and filling along sheeted zone in altered andesite. Ore minerals include pyrite, galena, and sphalerite.	----------------	Unknown - probably small.	Inaccessible; explored by several prospect cuts and a 150-foot (estimated depth) shaft. Structure appears to be extension of the Gold Cross vein system.
40	Iron Mask	24	7N	1W	Fracture filling and replacement vein in andesite. Widths range between 1-1/2 to 4 feet. Principal vein minerals: galena, pyrite, sphalerite, limonite, and quartz.	4.0% Pb, 7.4% Zn 0.2% Cu, 4.9 oz. Ag/ton	23,000 tons.	Developed by low-level crosscut adit and a 100-foot winze (flooded). Operation electrified and equipped with 50-ton selective flotation plant. Inactive in 1949.
41	January	26	8N	1W	Contact vein between quartz-monzonite and andesite; structure with waste inclusion up to 9 feet wide. Principal vein minerals - pyrite, galena, sphalerite with scant chalcopyrite and rhodochrosite in silicified gangue.	Recovered: 5.0% Pb, 3.4% Zn, 5.3 oz. Ag, 0.11 oz. Au/ton	3,100 tons since 1901.	Inaccessible; formerly developed over distance of 900 feet by 2 adits and winze. Last operated in 1931.
42	Little Bonanza	35,36	8N	1W	Fracture filling in andesite containing several lenticular ore shoots up to 3 feet wide. Principal vein minerals are galena, pyrite, and sphalerite in a silicified andesitic gangue.	Recovered: 37.7% Pb, 2.8% Zn, 26.0 oz. Ag/ton	300 tons since 1901.	Active in 1949; developed by 2 short adits. Equipped for small-scale operation.
43	Little Fannie	6	6N	1E	Flat-dipping replacement and fracture fill in andesite near the Indian Creek fault zone. Ore minerals include pyrite, limonite, cerussite, galena, and sparse sphalerite.	----------------	Unknown - not over 500 tons.	Underground workings aggregating about 800 feet consist of a short adit, a shallow vertical shaft and a main incline shaft all interconnected. Property idle and unequipped.
44	Little Olga (Kleinschmidt)	3	7N	1W	Several narrow fracture filling and replacement veins in quartz monzonite; wall rock intensely altered. Ore contains base metal sulfides with pyrite, and stephanite in a siliceous gangue.	Recovered: 6.7% Pb, 6.7% Zn, 18.7 oz. Ag, and 0.05 oz. Au/ton	4,300 tons produced since 1901.	Operation electrified; active in 1948 Development workings aggregate 9,000 feet. Vein penetrated 760 feet below outcrop by development adit.
45	Ruby	33	5N	1W	Pipe-shaped replacement in Madison limestone. Predominant vein minerals are smithsonite and cerussite in a siliceous gangue.	Recovered: 4.4% Pb, 8.8% Zn, 5.0 oz. Ag/ton	4,000 tons since 1901.	Important producer prior to 1901. Developed by incline shaft enlarged by stoping. Last operated in 1948. Workings in poor condition.
46	Summit (Mont. Silver Star)	17	4N	1W	Pipe-shaped bedding replacement in Madison limestone. Vein minerals are limonite, cerussite, smithsonite, and pyrolusite in a siliceous gangue.	Recovered: 10.6% Pb, 2.5% Zn, 8.5 oz. Ag/ton	2,000 tons since 1901.	Developed by 600-foot incline shaft. Briefly operated in 1948. Lead and silver amenable to standard flotation. Waelz process required for good zinc recovery.

1/ Classified according to principal or predominating metal or metals.
2/ Also known by name or names in parentheses.